1955, No. 1 February 18

Copeia

ESTABLISHED IN 1913

PUBLISHED BY

THE AMERICAN SOCIETY OF

ICHTHYOLOGISTS AND HERPETOLOGISTS

Copeia *1955, No. 1* *February 18*

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ICHTHYOLOGICAL NOTES

HERPETOLOGICAL NOTES

Published quarterly at Mt. Royal & Guilford Aves., Baltimore 2, Md. by the American Society of Ichthyologists and Herpetologists, The Florida State Museum, University of Florida, Gainesville, Florida. Entered as second class matter at the Post Office at Gainesville, Florida under the Act of August 24, 1912. Additional entry at the Post Office at Baltimore, Md. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized February 11, 1924.

1955 No. 1 COPEIA February 18

An Artificial Key to the New-World Species of Crocodilians

FRED MEDEM AND HYMEN MARX

THE identification of the crocodilians of the Western Hemisphere has long been difficult on account of inadequate comparative collections, unavailable literature, and difficulties of determination in the field. Only small numbers of specimens are usually received; lacking series, age groups, and comparative material, identification becomes difficult, especially if the specimens are juveniles. Students in zoological gardens, museums, and in the field have long felt the need for a positive and brief means of identifying specimens of living and preserved crocodilians.

In constructing the following artificial key, age differences, differences between living and preserved specimens, and the characters in skulls were all considered so that the condition of the animal does not limit the use of the key. This was made possible by the extensive collecting and field observations of the senior author and the large comparative crocodilian collections in the Chicago Natural History Museum. The senior author's personal collection has been presented to the above mentioned museum. Only one species is lacking in the combined collections, namely the Orinoco crocodile, *Crocodylus intermedius*. Dr. Doris Cochran of the United States National Museum was kind enough to lend us an excellent skull of this species plus other material. We wish to thank Dr. Robert F. Inger of the Chicago Natural History Museum for his extensive testing of this key and many helpful suggestions.

We recommend the use of Schmidt's crocodilian paper for comparative photographs. If common names are required, the reader may also refer to this paper (1944, Fauna, 6: 67–72).

1. Bony transverse pre-orbital ridge absent.....2
   Bony transverse pre-orbital ridge present.....8

2. Eyes brown; one or two rows of enlarged, strongly keeled occipital scales; supra-temporal fossae absent in adults, very small in juveniles; palpebrals (eyelids) completely ossified.....3
   Eyes not brown; one or two rows of few, smooth or feebly keeled occipital scales; large supra-temporal fossae in juveniles and adults.....4

3. Cranial table brown to reddish-brown; always two rows of strongly keeled occipital scales; width of snout at fourth maxillary teeth equaling length from tip of snout to posterior edge of third maxillary tooth[1]; in lower jaw, width of external mandibular foramen less than width of supra-angular and angular. Amazon-Orinoco Basin.....*Paleosuchus palpebrosus* Cuvier, 1807
   Cranial table blackish-brown; usually one row of strongly keeled occipital scales (if second is present, scales noticeably smaller than in first row); width of snout at fourth maxillary teeth equaling length from tip of snout to posterior edge of second maxillary tooth; width of external mandibular foramen greater than width of supra-angular and angular. Amazon-Orinoco Basin.....*Paleosuchus trigonatus* Schneider, 1801

4. Snout very broad and flat; nasal septum ossified. Restricted to southern United States.....*Alligator mississipiensis* Daudin, 1802
   Snout relatively narrow and high; nasal septum not ossified.....5

5. Snout relatively elongated, narrow, without median elevation along entire length of snout; profile concave; symphysis of mandibula extending to 6th mandibular tooth. Orinoco Basin.....*Crocodylus intermedius* Graves, 1819
   Snout not as elongated and narrow, with some median elevation along length of snout; profile not concave; symphysis of mandibles extending to 5th mandibular tooth.....6

6. Squamosals distinctly ridged. Restricted to Cuba.....*Crocodylus rhombifer* Cuvier, 1807
   Squamosals flat.....7

[1] The measurement "tip of snout to posterior edge of 2nd maxillary tooth" and similar measurements, are taken with calipers diagonally on the skull or snout of the specimen.

7. Adults distinctly larger; snout longer; adults and sub-adults with a median pre-orbital hump-like elevation ½ or less than ½ snout length; width of snout (all sizes) at 5th maxillary teeth as long as, or less than distance from tip of snout to 2nd maxillary tooth. Southern United States, Mexico, Central America to northern Colombia and western Ecuador..*Crocodylus acutus* Cuvier, 1807
Adults much smaller; snout shorter; in adults a median longitudinal elevation extending almost to nares; width of snout (all sizes) at 5th maxillary teeth as long as, or longer than distance from end of snout to 3rd maxillary tooth. Honduras, Guatemala, and southern Mexico (Tampico to Belize)..
.....*Crocodylus moreleti* C. & A. Duméril, 1851

8. Adults very large; occipital scale rows 4 to 5; orbit very large, extending at least to anterior edge of 10th maxillary tooth in adults; vomer in the cleaned skull clearly visible in juveniles, not clearly visible in adults. Amazon Basin.....*Melanosuchus niger* Spix, 1825
Adults much smaller; occipital scale rows mainly 2, sometimes 3; orbit much smaller, not extending to 9th or 10th maxillary tooth; vomer not visible in skulls of adults or juveniles.....9

9. Snout extremely short and broad; longitudinal ridge on snout longer than orbit. Southern Brazil southward to northern Argentina.....*Caiman latirostris* Daudin, 1802
Snout relatively longer; longitudinal ridge on snout absent, or, if present, shorter than orbit.....10

10. Snout relatively flat and broad; width of snout at 4th maxillary teeth greater than distance from tip of snout to 4th maxillary tooth. Colombia.....*Caiman sclerops*[2] (part) Schneider, 1801
Snout relatively higher and narrower; width of snout at 4th maxillary teeth equal to, or less than distance from tip of snout to 4th maxillary tooth.....11

11. Width of snout at 1st maxillary teeth equal to, or greater than anterior width of cranial table; dark black or brown spots on lower jaw and one or two black or brown spots on the upper jaw below eye. Paraguay River System.....*Caiman yacare* Daudin, 1802
Width of snout at 1st maxillary teeth less than anterior width of cranial table; no spots on head. Southern Mexico to northeastern Brazil..*Caiman sclerops* (part) Schneider, 1801 [= *Caiman crocodilus* L.]

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Experiments on Bluffing and Death-feigning in the Hognose Snake *Heterodon platyrhinos*

RICHARD A. EDGREN AND MARGERY K. EDGREN

THE so-called bluffing and death-feigning behavior of the hognose snakes, *Heterodon*, has excited much comment and speculation from biologists. Some have considered this behavior to be voluntary "bluffing" or "playing 'possum" whereas others have contemplated the psycho-physiological dynamics of the activity. Minton (1944) suggested that the behavior may be under volitional control or that letisimulation in these snakes may be akin to human narcolepsy. Hulme (1951) has described letisimulation in ringhals cobras and suggests fainting as an explanation. Hartman (1950), in a popular discussion, expressed the view that akinesia may be brought on by the effects of specific chemical substances diffusing from nervous centers; such substances would be destroyed eventually by enzymatic, oxidative, or other such processes. Edgren (1952) recently pointed out the similarities between the contortions of *Heterodon* and the physiological bases for the so-called "emergency theory" of adrenal medullary function.

In view of these suggestions it seemed logical to test the neuro-humors, sympathin E (norepinephrine) and acetylcholine (ACh), and epinephrine as possible chemical mediators of these activities. These substances act rapidly

[2] These are Colombian specimens usually known in the literature as *Caiman fuscus* Cope. The latter will be shown to be a sub-species of *C. sclerops* in a subsequent paper.

and are rapidly destroyed by enzymatic or other processes, and have well known pharmacological properties. Sympathin E is released at sympathetic nerve endings, and ACh at parasympathetic endings. The latter is also active in synaptic transfer. Epinephrine is the primary hormone of the adrenal medulla and, according to one theory, functions in mobilizing bodily resources during emergency situations.

Materials and Methods

A hognose snake, *Heterodon platyrhinos* Latreille, weighing 68.9 g., was obtained through the kindness of David A. Griggs, naturalist at Turkey Run State Park, Parke County, Indiana. The snake had been collected locally and maintained in the park museum for some time. It had been handled a great deal and showed none of the reactions associated with bluffing and death-feigning beyond some hissing and slight spreading of the hood.

All substances were administered intraperitoneally in aqueous solution. Epinephrine (Adrenalin, Parke, Davis and Co.) was administered at doses of 10, 30, 90, 180, 240, 480, and 800 μg.; acetylcholine chloride (Merck) was employed at doses of 0.1, 1.0 and 10.0 mg.; and nor-epinephrine (L-Arterenol bitartrate, Winthrop-Stearns) was injected at doses of 10, 50, 100, 500, 1000 μg. Water injections served as controls. Experiments were run in the laboratory under artificial illumination and at temperatures ranging between 24° and 28°C.

These studies were carried out in middle to late August; epinephrine was run first, ACh 4 days later, and nor-epinephrine 8 days after the ACh test. In the interval between the latter two series of experiments the snake shed its skin.

At least 5 minutes were allowed to elapse between epinephrine injections in the hope that adequate time would be allowed for metabolism of the hormone; longer periods (7 and 8 minutes) elapsed between ACh administrations; and in the final experiments with nor-epinephrine injections were spaced at 10-minute intervals.

Results

Epinephrine.—None of the dose levels employed stimulated more than slight hissing or hood-spreading. With initial injections some activity was noted but this did not differ significantly from reactions to control injections; later, higher doses of epinephrine did not elicit these responses. In an effort to determine whether the doses were "physiological," respiratory movements (depth and approximate rate) were noted, as were signs of pupillary dilatation. Neither sign showed recognizable changes after injection.

Acetylcholine.—All three levels of ACh stimulated local contraction of skeletal muscle near the site of injection. This contraction was marked by a constriction of the body in this area; it was sufficient to raise the ventrals above the substrate, to abolish ventral movement, and to inhibit local undulations.

Systemic effects were noted only with the highest dose given. Extremely deep, spasmodic respiratory movements began 4 to 5 minutes after injection. At the same time, spasmodic "chewing" movements were noted. At about 7 minutes, the jaws were opened slightly and immediately closed. Upper jaw movements, most apparent in the temporal region, also began at this time. These jaw movements continued irregularly throughout the observations which were terminated 30 minutes after the injection. At 11.5 minutes, bubbling from the nares was first observed; this also continued till 30 minutes. At 25.5 minutes, drooling from the sides of the mouth at about the level of the eyes was observed.

Nor-epinephrine.—As with epinephrine this substance had little obvious effect upon the snake. Counts of respiratory movements, however, showed a progressive decrease with increasing doses of the compound. Doses and respiratory rates were as follows:

Dose (μg)	Rate (Movements/minute)
50	32
100	28
500	24
1000	16

These movements were also abnormal at the highest dose; they were primarily shallow, and after each 8 to 10 movements respiration was suspended for a few seconds. Extremely deep movements were noted at irregular intervals throughout this period of observation.

Discussion

The above results suggest that the bluffing and letisimulatory behavior of *Heterodon platyrhinos* is not stimulated by injections of nor-epinephrine, epinephrine or acetylcholine. Although it is not possible to state with certainty that the doses of epinephrine used were "physiological," it seems probable that such extremely high doses as 800 μg (approximately 10 mg./kg.) were physiologically active, as this level is much higher than the approximate IP LD_{50} for rats (Farris and Griffith, 1949: 343).

The effects obtained with ACh may all be interpreted on the basis of the known pharmacodynamics of the substance. Spasms of the intercostal muscles were undoubtedly the result of motor end plate stimulation, which is mediated by endogenous ACh (Best and Taylor, 1945: 948). The spasmodic respiratory movements and "salivation," and probably the jaw movements also, are typical signs of parasympathetic stimulation. ACh, through stimulation of this branch of the autonomic nervous system, is known to cause salivation (Best and Taylor, *op. cit.*: 422), and to contract the bronchi (Best and Taylor, *op. cit.*: 948). The latter effects, in addition to direct muscular stimulation, would probably cause spasmodic respiratory movements and jaw movements as a "gasping" response. ACh is also known to be a rather general central stimulant (Best and Taylor, *op. cit.*: 821).

The abnormalities of respiratory movements noted with nor-epinephrine suggest that this substance may have had actual physiological effects in the experiments. Respiratory changes in mammals following nor-epinephrine injection or other sympathetic stimulation are secondary to changes in blood pressure and are marked by acceleration in rate and increase in depth (Best and Taylor, *op. cit.*: 687). That the response of *Heterodon* is opposite seems of particular interest, as does the apparent refractoriness of the snake to all three substances.

In the light of the known activities of these compounds, our experimental results seem to rule out several possible explanations of the bluffing and death-feigning behavior in *Heterodon*. The failure of epinephrine to stimulate the action suggests that the adrenal medulla is not involved, assuming that the doses administered were at physiological levels. ACh failure tends to exclude both the parasympathetic nervous system and general stimulation of skeletal muscle. The absence of the behavior after nor-epinephrine, and after epinephrine in view of its sympathicomimetic action, implies that the sympathetic nervous system may not be the mediator of the activities.

The mediator of bluffing and letisimulation in *Heterodon* remains unknown. Failure of the substances used in these experiments seems to preclude their consideration with regard to their peripheral effects, although no information is available concerning their influences on the central nervous system. It seems probable that these activities of *Heterodon* are best considered as central humoral or reflex effects which are hardly amenable to present experimental analysis.

We are indebted to Dr. Albert Wolfson of Northwestern University who originally suggested the use of epinephrine, and to Drs. F. J. Saunders, W. E. Hambourger, C. G. Van Arman, and F. M. Sturtevant of G. D. Searle and Company for suggestions on the use of the compounds and the interpretation of the results.

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Division of Biological Research, G. D. Searle and Company, P. O. Box 5110, Chicago 80, Illinois.

Observations on the Life History of the Soft-shelled Turtle *Trionyx ferox,* with Especial Reference to Growth

W. J. Breckenridge

THE life histories of the American soft-shelled turtles have not been extensively studied. The fact that *Trionyx ferox* is abundant in the Mississippi River at my home 5 miles north of the city limits of Minneapolis, Minnesota, prompted me to initiate a study of this animal several years ago, and the information secured to date is presented in this preliminary report.

The study was set up primarily to probe into the growth rate, longevity, and local movements of the animals. It originated as a small-scale, spare-time activity to test the feasibility of retrapping soft-shelled turtles in this habitat. During the last 3 years a University of Minnesota Graduate School grant has aided in the purchase of traps and has allowed for the employment of assistance in the field work.

The local population of this turtle is included by Conant and Goin (1948) within the area of intergradation between *T. ferox spinifera* and *T. f. hartwegi*. The carapace markings on turtles examined tend strongly toward *T. f. spinifera*.

Habitat.—The river at this point (5 mi. N of Minneapolis), which seems highly favorable for soft-shelled turtles, is fairly swift, and the river bed consists largely of glacial debris ranging from pebbles to boulders 6 feet in diameter. Sandy islands (Fig. 1) in the channel vary somewhat in size and location due to high-water action. Water levels fluctuate abnormally at this point, due to the control of gates in a power dam 1½ miles upstream. During spring floods the waters cover about one-third of the large island. The islets and the sandy banks afford nesting places required by this turtle, although most of the river banks are muddy, suitable only as basking places. Since stomach analyses from this area (Breckenridge, 1944) and elsewhere (Lagler, 1940) have shown crayfish to be a staple food of soft-shelled turtles, an abundance of these crustaceans here is another favorable habitat factor.

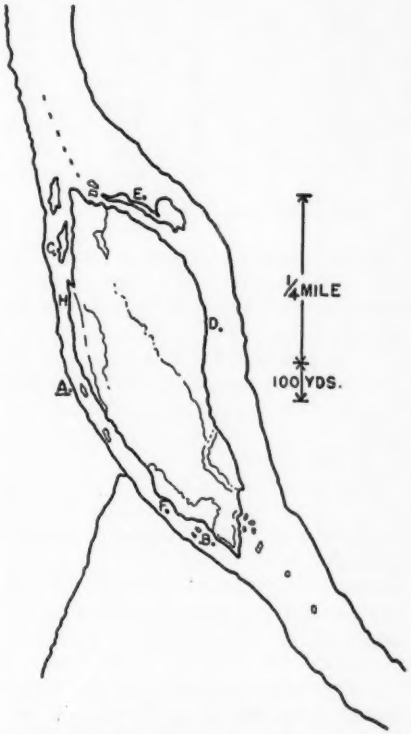

Fig. 1. Mississippi River showing turtle trapping stations (B–H) and the point of release (A).

Trapping.—Capture of the turtles has been attempted with several types of traps. The common 3-hoop nets of heavy cord with a circular front leading to a horizontally flattened entrance proved most successful. These were baited with chicken heads or other fresh meat enclosed in a punctured tin can suspended in the back of the trap. Similar traps made of woven wire were used with some success. A low, rectangular trap was built of ¼-inch mesh wire. It was equipped with a hinged front that curved inward and which could be raised by a turtle as it pushed its way into the trap for the bait. This type only rarely captured a turtle. A drop trap with a broad treadle to take turtles on their basking banks was devised, but this met with no success.

Marking.—At the start of the study the

TABLE I
DISTANCES TRAVELLED BY *Trionyx ferox*

Turtle number	Point of capture	Point of recapture	Time elapsed	Distance travelled, in yards
8-12	B	B	2 da.	0
1-11-12	C	C	2 da.	0
10-12	C	C	3 da.	0
8-12	B	B	1 mo.	0
10	. . *	H	3 mo.	200
5- 5	F	B	2 yr.	100
2-11	F	B	2 yr.	100
2-10	D	B	2 yr.	600

* St. Croix River, released at A.

individual turtles were marked by notching the edge of the carapace with a leather punch at points corresponding to the positions of the hours on a clock. These notches healed readily, and over periods of 3, 4 or 5 years grew out somewhat, but remained discernible as shallow sinuses. When turtles were retaken after extended periods, they were remarked adjacent to the former mark.

Use was made at one time of a tool such as is used by fox farmers in tattooing the inner lining of fox ears. This consisted of a buzzer mechanism, driven by dry cell batteries, which vibrated a set of needles that injected India ink into the surface covering. Numbers were tattooed onto the whitish plastron. No turtles so marked were ever recognized as recovered.

In 1949, numbered brass rivets were slipped through holes punched in the carapace and clinched over brass washers beneath. Of 39 animals so marked, none was recovered with the rivet in place, although 11 turtles with rivet holes were retaken. One of these was recovered only 2 months after marking. The pressure and perhaps the reaction to the brass may have killed the tissue, allowing the rivets to drop out.

Only the shell notching has proved satisfactory, and this is the only marking technique now used.

SEX CHARACTERS.—The sexes were separated on the basis of the tail structure. One sex character that appears to have been overlooked in most descriptions is that the dorsal surface of the carapace in females is very smooth to the touch, while in males small, sharp protuberances scattered over this surface give a decidedly gritty or sandy feel to the carapace. Females between 5 and 6 inches in carapace length show a definite mottled pattern developing among the spots. This undoubtedly indicates a stage in the attainment of sexual maturity. Mitsukuri (1905) reported that Japanese soft-shells begin laying in their sixth year (7 to 8 inches in carapace length). This suggests that *T. ferox* reaches sexual maturity earlier, although it is slightly larger than *T. japonicus*.

LOCAL MOVEMENTS.—The recapture data indicate that the cruising radius of at least a large part of the population of these turtles is very much limited. One hundred and seventy-two individual turtles have been trapped and marked within the limits of the half-mile-long island. All turtles trapped were taken to my house (Fig. 1, A) for marking and were released on the river bank at that point. Thirty of these have been retaken over a period of 7 years within these same limits, with an average period between captures of slightly more than 1½ years. Early in the study the exact locations of the trapping point were not recorded, but the data on recorded retakes emphasize the limited range of these turtles (Table I).

One of the turtles (No. 10) is of particular interest because it shows the sedentary nature of this species. This specimen (12-inch carapace length) was taken originally in the St. Croix River 70 miles to the northeast of the study area. It was marked and released (at A, Fig. 1) on June 1 and was retaken 3 months later only 200 yards away. Supporting this evidence is the statement of a professional turtle trapper to the effect that, after a section of a river has been trapped heavily for soft-shells, little success can be expected in that area for as much as 3 or 4 years thereafter. The limited range of these individuals is surprising in view of the fact that this most agile swimmer among the turtles is here living in swiftly flowing waters.

SIZE.—During the study, 172 specimens were taken. Of these, 92 were determined as females and 71 as males. The maximum carapace length for females was 15½ inches; the two largest males taken were each 7½ inches. The largest male (7⅜ in.) on which weight was recorded weighed 1 pound, 5 ounces; the largest female (14 15/16 in.), 9 pounds, 8 ounces. A professional turtle trapper, Mr. A. Kurtz, brought to me on September 3, 1947, a female

TABLE II

CARAPACE LENGTH IN *Trionyx ferox*

Size group (in inches)	Number of specimens (including recaptures)
Females:	
2— 2⅞	4
3— 3⅞	0
4— 4⅞	4
5— 5⅞	11
6— 6⅞	6
7— 7⅞	10
8— 8⅞	19
9— 9⅞	13
10—10⅞	10
11—11⅞	19
12—12⅞	11
13—13⅞	4
14—14⅞	4
15—15⅞	2
Males:	
2— 2⅞	1
3— 3⅞	0
4— 4⅞	2
5— 5⅞	30
6— 6⅞	34
7— 7⅞	7

spiny soft-shelled turtle, taken in the Mississippi River 12 to 15 miles above the study area, that was 17 inches in carapace length and weighed 15 pounds. This is the largest specimen of this species of which I have a record. Only a few small turtles were taken by me, since nearly all traps used were of 4-inch mesh.

Among females the number of individuals remains nearly constant in the size groups from 5 inches up to 13 inches in carapace length (age range 3 to 19 years, as shown later); size groups above 13 inches contain few individuals. Only two were taken that exceeded 15 inches. This suggests that animals between 5 and 12+ inches in length suffer but little natural mortality, and that various factors associated in some way with senility begin to cut down the population rapidly at about the 13-inch size. The same suggestion is found in the data for the males, where 5 inches to 7 inches represents a similar age range (Table II).

GROWTH RATE.—Since the males and females of this turtle differ greatly in size, it is necessary to consider growth data for the sexes separately. Eleven recaptures of females were made at

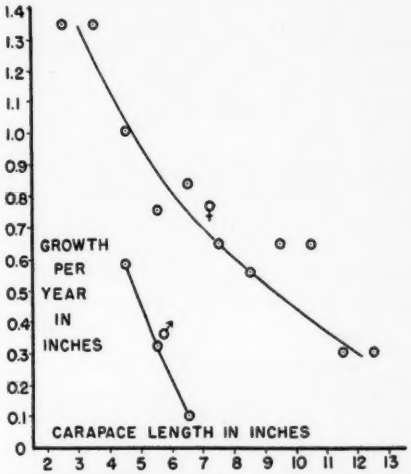

Fig. 2. Growth curves based on growth rates from field data.

TABLE III

YEARLY GROWTH INCREMENTS FOR INDIVIDUAL SOFT-SHELLED TURTLES

Carapace length in inches										
2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11	11–12	12–13
Females										
1.35	1.35	1.35	.76	.76	.76	.35	.42	.42	.31	.31
		.76		.89	.35	.89	.89	.89		
				.87	.35	.26				
					.89	.26				
					.87	.87				
						.73				
		Av.		*Av.*	*Av.*	*Av.*	*Av.*	*Av.*		
		1.05		.84	.64	.56	.66	.66		
Males										
		.59	.59	.11						
			.06							
			Av.							
			.32							

intervals sufficiently great (about 1 year or more) to record measurable growth. One individual was recaptured approximately 5 years after it was originally marked. In developing the growth graph (Fig. 2), the writer considered all growth data in 1-inch increment groups (Table III). Any growth record which overlapped one of these groups was used in computing an average growth rate for turtles

Fig. 3. Growth rates for female turtles plotted on semilogarithm paper.

Fig. 4. Size-age growth curve for female turtles

within that size range. As an example, one turtle was taken at 2¼ inches in length and recaptured at 5 inches in length. The per-year growth rate of 1.35 inches is used in three 1-inch increment groups, 2–3, 3–4, and 4–5. Since the length of the growing season is not definitely known, all growth calculations have been made on an annual basis. Thus, 25 separate growth rate records were considered in securing the female growth curve (Fig. 2). Both the highest rate (1.35 in. per year) and the lowest rate (0.31 in. per year) are based on single records, while the 8–9-inch rate is based on six individual records. Considering hatchling size (approximately 1½ in.) and known growth rates, it is reasonable to assume that the smallest turtle on which a growth rate was secured (2¼ in.) was about 1 year old at the time of original capture (July 28).

The female growth curve (Fig. 2) was drawn through the points, with greater importance being attached to those values which were based on the greater number of field records. The growth curve as shown is applicable only to the carapace length range of 3 to 12 inches. This range can be extended at both ends by a process of extrapolation. The extrapolation can be done graphically by replotting the curve on coordinate scales which will produce a straight line. This was done (Fig. 3) by using a linear growth scale and a logarithmic length scale. By extending the straight line down to the length axis where the growth rate is zero, the theoretical maximum size of 18 inches was obtained (largest recorded specimen, 17 inches). The minimum size (hatching size) is known to be approximately 1½ inches. The hatchling growth rate was determined by extending the growth line upward until it intersected the 1½-inch abscissa. This rate (Fig. 3) is 1.88 inches per year, and it provides a starting point from which to build the age curve (Fig. 4). When the turtle has grown to 2 inches, its rate of growth has decreased to 1.66 inches per year. The average rate is 1.77, and the time required to grow ½ inch is equal to ½ inch divided by 1.77 inches per year. Thus, a 2-inch turtle is 0.28 year old. The time required to grow another ½ inch is computed as follows:

Growth rate at 2 inches	= 1.66
Growth rate at 2.5 inches	= 1.49
Average rate	= 1.58

$$\text{Time} = \frac{\text{Growth increment}}{1.58} = \frac{0.50 \text{ inch}}{0.32 \text{ year}}$$

The age of the 2½-inch turtle is 0.28 year plus 0.32 year or 0.60 year. The remainder of the age curve was developed by carrying out this procedure in ½-inch increments of length until the 18-inch or maximum size was reached. This curve (Fig. 4) indicates that a 10-year-old female is about 9.8 inches in carapace length; a 15-year-old turtle, 11.7 inches; a 20-year-old, 13.1 inches; and a 30-year-old, 15 inches. The age of the 17-inch specimen would lie beyond the curve, and according to the calculations, would be approximately 53 years old. Females (presumably) of the Japanese soft-shelled turtle, *Trionyx japonicus* (a slightly smaller species), reared in captivity grew in 5 years to a carapace length of 6.9 inches (Mitsukuri, *op. cit.*), exactly the same size as determined for *T. ferox* in this study.

Only four growth rate records were available from which to construct the growth line for male turtles (Fig. 2). This is hardly sufficient evidence on which to base an age curve. However, it seems logical to assume that the sexes, which are the same size at hatching, would develop at about the same rate in early life previous to sexual maturity. Thus, extending the growth rate line for males along that of females in the 2–4-inch size groups (1.35 per year) would indicate that a 10-year-old male would be approximately 6¼ inches in carapace length, while at 15 years it would be but 6¾ inches.

The assistance of Mr. Morris Self in making the mathematical calculations connected with the growth curves in Figures 3 and 4 is gratefully acknowledged. Thanks are also extended to Dr. Lloyd Smith, Jr., and Dr. Ralph Hile for critical reading of the manuscript and for suggestions.

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Embryonic Growth of *Thamnophis s. sirtalis* in Relation to Fertilization Date and Placental Function

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In the course of an investigation of excreta and excretory mechanisms of the gartersnake embryo, in which a succession of excretory products appear, it was important to know the age of the embryo. This is equally desirable for consideration of other physiological functions of the embryo, since new physiological devices commonly appear abruptly and are often associated with other phenomena of differentiation. Hitherto, there has been no satisfactory way of ascertaining the age of gartersnake embryos.

Embryonic weight data were accumulated in relation to excretion and fat analyses and as normal controls of these two series. Embryos were taken from 12 females of *Thamnophis s. sirtalis* (L.). The snakes were collected principally locally during May and June, and during the course of the studies were maintained on a diet of earthworms. Embryonic weights were determined on a Roller-Smith balance. Serial operations for removal of the embryos were performed by the technique described by Clark (1937).

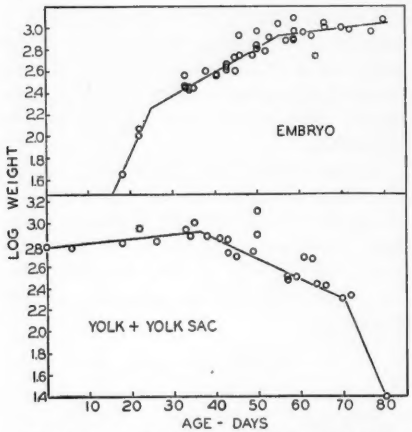

Fig. 1. *Above:* Semilog plot of growth of gartersnake embryos. Ordinate, log wet weight; abscissa, age in days. Equations for the three portions of the curve are: $y = 0.0945x - 0.04$ (0–25 days); $y = 0.022x + 1.72$ (25–53 days); $y = 0.0044x + 2.676$ (55–80 days). From the growth equation $W = Ae^{kT}$, where W = weight, A = ln W when T = 0, e = base of natural logarithms, T = time (age), k = growth constant describing instantaneous rate of growth during interval chosen, k values are 0.197 (0–25 days), 0.055 (25–53 days), and 0.010 (55–80 days). *Below:* Semilog plot of change in mass of yolk plus yolk sac. Equations for the three portions of the curve are: $y = 0.005x + 2.772$ (0–35 days); $y = 3.419 - 0.014x$ (35–72 days); $y = 10.614 - 0.115x$ (72–80 days). Corresponding k values are: 0.005, −0.032, −0.291.

In addition to the establishment of fertilization date for each of the females, factors concerned with embryonic growth, including the role of the placenta, are presented below.

Fertilization Date

It is well known that the copulation date of gartersnakes is variable depending chiefly upon temperature during a single season. Rahn (1940) pointed out that sperm may survive in the female genital tract for a period of weeks. Hence the actual time of fertilization of a particular female is subject also to variation, and it is possible that there may be a considerable time span for fertilization of all the eggs. The technique for determination of the fertilization date, hence embryonic age, follows.

The logarithm of embryonic weight was plotted against age, calculated on the basis of a common fertilization date, June 1. Equations describing the distribution of data were then determined by the method of least squares in order to provide objectivity in the next step.

Table I

Variation in Weight of Prenatal Litter Mates of *Thamnophis s. sirtalis*

Operation number	Operation date	Identification number of mother	Embryonic weight, in grams
(1)	7–6	3–2	0.399, 0.533
(1)	7–7	3–3	0.360, 0.291, 0.279
(1)	8–13	5–7	0.574, 0.708, 0.757, 0.767, 0.918
(2)	7–17	1–0	0.434, 0.408, 0.440
(3)	7–28	2–3	0.702, 1.192
(4)	7–29	4–3	0.636, 0.670
(3)	8–6	4–2	0.768, 0.759, 1.193
(4)	8–13	4–2	1.004, 1.098

The algebraic sum of deviations of age of siblings from the theoretical curve was determined mechanically, and the fertilization date of the mother was adjusted with reference to the originally assumed June 1. With the new fertilization dates for the 12 females, hence revised age of their embryos, the plot of log weight against age was again made, and the same procedure was followed in readjusting the fertilization date. The second adjustment of fertilization date has been accepted as final, and the growth curve (Fig. 1) is presented on this basis.

Growth

The range of embryonic weights recorded was 0.045 g. to 1.401 g. These data are listed (Table II) and are shown graphically (Fig. 1). It is apparent that in the readjustments by algebraic summation of deviations from the curve descriptive of the data, not all variability has been removed. It is believed that the residual variation approximates the true "normal" variation within a brood. This conclusion is accentuated by a statement of weights of embryos removed in groups on the same day (Table I). Evidence is presented below to indicate that a substantial portion of embryonic wet weight derives from materials transmitted from the mother to the embryo. Hence, it occurred to us that the operation *per se* may have produced some of the variation, since ligation of branches of the uterine artery was required for removal of segments of the uterus. Hence the serial number of the operation is included with other data (Table I). It is at once

TABLE II

WET WEIGHTS OF EMBRYOS AND YOLK PLUS YOLK SAC IN *Thamnophis s. sirtalis*

Weights in milligrams, age in days

Identification number of mother	Age	Weight of embryos	Weight of yolk and yolk sac
0–2	Unfert.	..	606
4–3	6	..	600
5–5	18	45.0	656
4–3	22	100.4	882
1–0	22	119.0	..
1–4	26	..	679
3–3	33	279	..
3–3	33	291	..
3–3	33	360	869
4–3	34	269	765
4–3	34	282	..
2–3	35	273	1000
2–0	38	401	757
3–3	41	363	..
3–3	41	373	728
1–0	43	408	..
1–0	43	434	537
1–0	43	440	..
4–3	43	459	733
3–2	45	399	..
3–2	45	533	493
4–2	46	564	..
4–2	46	566	..
5–7	46	799	..
2–3	49	565	553
4–3	50	636	770
4–3	50	670	..
3–3	50	907	1303
5–4	52	597	..
4–2	53	820	..
4–4	55	1098	..
5–4	57	680	327
5–4	57	762	300
5–4	59	932	323
4–2	59	759	..
4–2	59	768	..
4–2	59	1193	..
3–3	61	904	485
2–3	63	702	..
2–3	63	1192	467
5–4	64	555	277
4–2	66	1004	..
4–2	66	1098	..
0–3	67	..	269
3–2	70	994	260
5–4	72	961	214
5–7	77	574	..
5–7	77	708	..
5–7	77	757	..
5–7	77	767	..
5–7	77	918	0
5–4	80	1206	25

apparent from examination of weights of embryos obtained at the first operation that the operation was not the sole, nor indeed the principal, factor in producing weight variation among litter mates of the same age.

PLACENTAL FUNCTION

Presence of the placenta, which inevitably serves a respiratory function for the embryo, raises also the question of its role in nutrition. Specific data are at hand with respect to relative wet weights of the yolk plus yolk sac and embryo throughout development, and to fat content during the last third of development.

The yolk and yolk sac could not be separated with accuracy. The weights of the combined yolk and yolk sac are presented, with corresponding embryonic weights for comparison (Table II). The graphic representation of yolk plus yolk sac is shown below; k values for yolk content are set forth in the legend of Figure 1. At the end of the most rapid period of embryonic growth ($k = 0.197$) during which the weight of the yolk sac has approximately equalled that of the embryo, the weight of combined yolk and yolk sac has increased. During the next phase of embryonic growth ($k = 0.055$), the weight of yolk plus yolk sac declines at a constant rate. During this period of 53 days of embryonic growth, which is approximately two-thirds of the developmental period, then, 825 mg. of embryonic tissue have been formed, plus an estimated 250 mg. of embryonic membranes; and the yolk sac contents, though decreasing in quantity, have not fallen below the initial unfertilized value. This observation points to a transplacental flow at least of water.

This fact is again demonstrated by comparison of the water of the embryo with that initially available in the egg. The analyses of Galimard (1904) and of Sommer and Wetzel (1904) on the eggs of *Natrix natrix*, suggest that approximately 50 percent or 300 mg. of the egg is water. The water content of the embryo at birth is approximately 960 mg. Clearly, 660 mg. is unaccounted for by original yolk content of water. This amount must be derived either from the mother or from fat combustion.

Fat lost by the yolk from 46 days to 67 days was 98.5 mg., and that gained by the embryo was 33.0 mg. (Fig. 2). It is apparent that the yolk could easily have supplied the fat detected

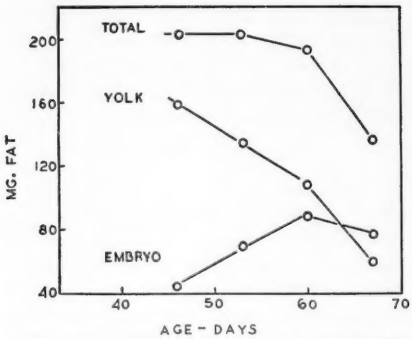

Fig. 2. Fat content of embryo and of yolk plus yolk sac. The combined fat content is shown and the decline indicates the amount of fat burned during this interval.

TABLE III

SUMMARY OF COMPONENTS OF EGG AND NEONATAL GARTERSNAKE IN MILLIGRAMS

Components	Egg	Neonate
Water	300	960
Dry matter		
Fat	200	90
Protein	80	135
Ash	25	25
Total	305	250

in the embryo, and the remaining 65.5 mg. would have been available for combustion. The combustion of this quantity of fat might yield 70 mg. of water, a quantity far short of that gained by the embryo; the reliance on fat as a source of energy particularly in the latter period of incubation by cleidoic eggs has been suggested as a water conserving device (Needham, 1950). No observation suggesting transplacental origin of embryonic fat was made.

With reference to other protoplasmic constituents, no directly measured data are available. It may not be amiss, however, to estimate on the basis of a 2.5:1 fat-protein ratio of the unincubated egg (Needham, 1931) that 55 mg. protein (41 percent of the embryonic content) is not available from the egg. It appears, therefore, that amino acids must be supplied from the maternal blood stream. The comparison of egg and embryonic contents are set forth on the basis of: (1) 50 percent water content of the egg, and (2) 2.5:1 protein fat ratio (Table III).

PLACENTAL STRUCTURE

The gartersnake placenta is of the epitheliochorial type, of which the blood supply is allantoic. Areas of chorionic erosion occur, suggestive of a cotyledonary type of placenta. Details of placental structure will be described elsewhere.

DISCUSSION

The technique herein described for determining fertilization age is of limited use for the reasons that it can apply only to *Thamnophis s. sirtalis* until otherwise demonstrated. Since determination of the fertilization date of the animal involves either sacrifice of the mother or Caesarean operation, the technique is of particular use in embryological studies. The method would appear to have some support in the observation of Bragdon (1951) that ovulation in a mixed local population was distributed over a three weeks period, almost identical with that reported herein.

With respect to the placenta, the present report provides the only indication, of which the authors are aware, of a non-respiratory function. The clearly indicated service of the placenta in supplementing ovarian water supply and the inferential service in providing a source of amino acids for embryogenesis, point to the desirability of a detailed analysis of the trans-placental nutrients and gaseous exchange as well.

The finding with respect to placental function marks the gartersnake egg as non-cleidoic. In this respect it deviates from the pattern of some saurian reptiles such as desert forms which develop outside the body of the mother (Cunningham and Huene, 1938), and resembles others such as *Elaphe* (Clark, 1953), *Natrix* (Portman, 1935), and turtle (Imamura, 1939).

This report is an outgrowth of an excretory study of the gartersnake embryo supported in part by a research grant (G-3827) from the National Institute of Health, U. S. Public Health Service.

SUMMARY

1. The prenatal growth curve of *Thamnophis s. sirtalis* (L.) is described.

2. Fertilization date is calculated by adjusting age to fit the growth curve to the extent of the algebraic sum of deviations by siblings.

3. Evidence is presented that water is re-

ceived by the embryo from the mother, that amino acids probably are transmitted, and that fat probably is not transmitted.

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The Relationships of the Soft-shelled Turtles *Trionyx ferox ferox* and *Trionyx ferox aspera*

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During the course of several years' field work in southwestern Georgia and northwestern Florida, a number of soft-shelled turtles representing the subspecies *Trionyx ferox ferox* Schneider and *T. f. aspera* Agassiz were obtained. The distribution of these individuals clearly indicates that the spatial and genetic relationships between the two races is at variance with that postulated by Neill (1951: 12).

Neill (*ibid.:* 11) defined the known range of typical *T. f. ferox* as peninsular Florida, northward to and including the St. Marys River on the east and the Suwannee River and its tributaries on the west (Fig. 1). The St. Marys and Suwannee rivers drain the Okefenokee Swamp of southeastern Georgia and flow eastward to the Atlantic Ocean and southwestward to the Gulf of Mexico, respectively, thus forming a natural waterway isolating most of peninsular Florida and a small part of southeastern Georgia from the remainder of the southeastern United States. Neill (*ibid.:* 10–2) reported intergradation between *T. f. ferox* and *T. f. agassizi* in Atlantic drainage streams immediately to the north of the St. Marys River, indicating a subspecific relationship between the two forms. He further reported a subspecific relationship, based on intergradation, between *ferox* and *aspera* to the northwest of the Suwannee River.

In the present study, we have concerned ourselves primarily with the reported area of intergradation between *ferox* and *aspera*. For comparative purposes, we have examined a number of specimens of *ferox* from beyond the presently accepted range of *aspera*, i.e., south of the Suwannee and St. Marys rivers, and a series of *aspera* from beyond the known range of *ferox*, i.e., northwest of the Apalachicola River system.

The southern spiny soft-shelled turtle, *T. f. aspera*, was reported by Goin (1948: 304) from the Blackwater, Chattahoochee, and Ochlocknee rivers of northwestern Florida. Neill (*op. cit.:* 12) examined large series of all sizes of this subspecies from the Apalachicola River system, including the Chipola River in Florida, and the Chattahoochee and Flint Rivers of Georgia. He also observed it in the Ochlocknee River. All of the rivers named above empty into the Gulf of Mexico, the Blackwater and Ochlocknee rivers lying to the west and east respectively of the Apalachicola River system.

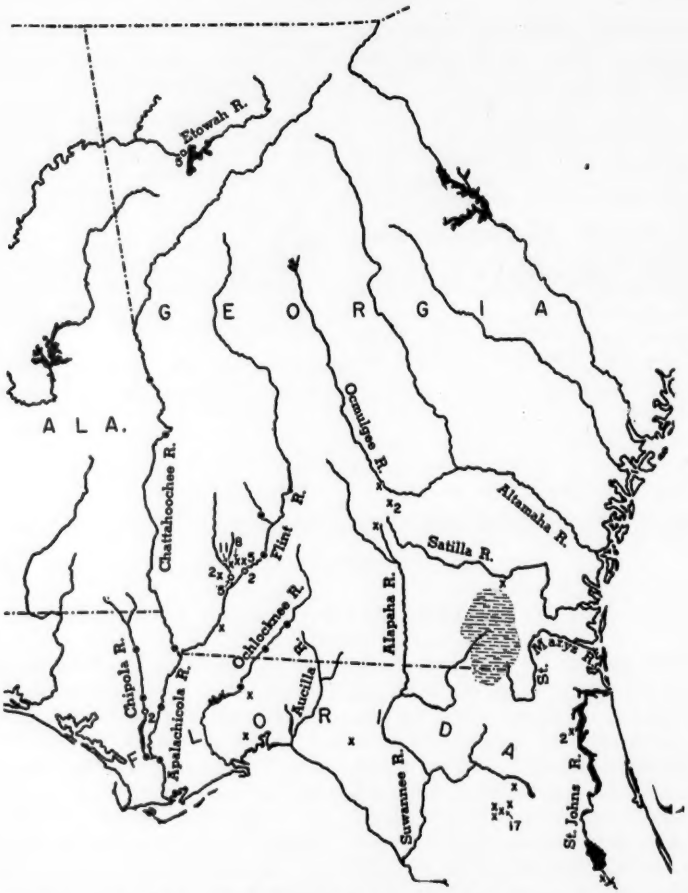

Fig. 1. Locality records of *Trionyx ferox ferox* and *T. f. aspera* in and adjacent to the area of their geographic overlap. Circles represent localities from which specimens of *aspera* were examined; solid spots represent published records. Crosses represent localities from which specimens of *ferox* were examined. Numerals adjacent to symbols represent the number of specimens examined. Symbols without adjacent numerals represent localities from which only one specimen was examined.

The Ochlocknee is, thus, the easternmost of the streams known to be inhabited by *aspera*.

Neill (*ibid.*: 12) reported that "two specimens from the Flint River drainage in Macon County, Georgia, while essentially *aspera*, apparently show attenuated *ferox* characters," and one specimen from the Aucilla River, east of the Ochlocknee River, in Georgia, was termed a definite intergrade between the two forms. We have not been able to obtain these specimens for examination but feel, for reasons to be given shortly, that they must represent either aberrant individuals or the results of infrequent hybridization. The characters that are given as indicative of their intermediate nature are either highly subjective or of questionable validity.

We have examined nine *aspera* from the Flint River and its tributaries in Baker County, Georgia, and the Chipola River in Calhoun County, Florida, one large adult (United States National Museum (USNM) 134249) and eight juveniles and subadults (USNM 134243–8 and University of Georgia (UGC) 146 series). In addition we have collected five subadults (UGC 145 series) from beyond the range of *ferox* in

the Etowah River, a tributary of the Coosa and Alabama rivers, below Allatoona Dam, Bartow County, Georgia.

Carr (1952: 414–20) summarized the known distribution of *ferox* in peninsular Florida and southern Georgia. With respect to the northward limits of this race, Wright and Funkhouser (1915: 119–23) and Neill (1951: 11) have examined representative series from the Okefenokee Swamp in southeastern Georgia, and Neill (*ibid.*: 23) has mapped other specimens examined by him from the lower and middle Suwannee River in Florida, and from a Suwannee River tributary, probably the Alapaha River, in south-central Georgia.

Stejneger (1944: 42–3) listed eight specimens of *ferox*, presently in the United States National Museum, from localities northwest of the Suwannee River drainage system. Neill (*op. cit.*: 8) examined two of these specimens (USNM 70398 and 029619) and referred them to *aspera*. We also have examined two of the specimens listed by Stejneger (USNM 38980 and 38981), both alcoholic examples in especially good condition, and find them clearly referable to *ferox*. Both were collected by Brimley near Mimmsville, Baker County, Georgia between the Flint and Chattahoochee rivers. From situations near the Mimmsville locality and within the same county, we have collected two series of *ferox*. One of these, a series of nine specimens (USNM 134233–41), was collected in Rock Hole Pond, 5 miles northwest of Newton, Baker County, Georgia. The other, consisting of eight specimens (Tulane University (TUC) 16161–6) and Private collection of John W. Crenshaw (JWC) 820 G, H), was collected in Ocean Pond, 5 miles west of Newton, Baker County, Georgia. Two other specimens of *ferox* (USNM 134230–1) were taken on different occasions from the Rock Hole Pond locality. We have also examined a series of five specimens (UGC 107 series) collected in a limesink pond 4 miles north of Newton, Baker County, Georgia. The existence of these populations of *ferox* from beyond the range of the subspecies as delimited by Neill (*ibid.*: 11) and from an area bounded by the Flint and Chattahoochee rivers, both of which are known to be inhabited by populations of *aspera*, clearly negates the possibility of a continuous zone of intergradation between *aspera* and *ferox*.

Several other specimens that we have examined indicate that the geographic overlap without intergradation reported above is not a purely local situation. A specimen (USNM 134232) from near Bainbridge, Decatur County, Georgia, between the Flint and Ochlocknee rivers, both of which are inhabited by *aspera*, is clearly *ferox*. USNM 103736, an alcoholic specimen in excellent condition, correctly listed by Stejneger (*loc. cit.*) as *ferox*, was taken at Silver Lake, Leon County, Florida, and another, University of Florida (UF) 4366, was collected near Crawfordville, Wakulla County, Florida. Both of these localities lie between the *aspera*-inhabited Ochlocknee River and the Aucilla River, to the east, where an intergrade was reported (Neill, *op. cit.*: 12). A specimen of *ferox* (UF 1332) from near Foley, Taylor County, Florida, midway between the Aucilla River and the *ferox*-inhabited Suwannee River, serves to complete the chain.

In southcentral Georgia, where intergradation between *ferox* and *aspera-agassizi* populations was postulated (Neill, 1951: 11), we obtained three typical *ferox*, one of these (USNM 134229) from a small limesink pond, about 3 miles southeast of Forest Glen in Wilcox County, Georgia between the *aspera*-inhabited Flint River and the *agassizi*-inhabited Ocmulgee River and within a mile of the latter stream. Two others (USNM 134228 and 134242) were taken from a small flatwoods cypress pond 6 miles east of Fitzgerald, Ben Hill County, Georgia, midway between the source of the Satilla River and the lower Ocmulgee River. According to Neill (*ibid.*) the Satilla River is inhabited by soft-shelled turtles which "apparently incline definitely toward *ferox* although with *agassizi* influence still evident." He judged the soft-shelled turtles of the Ocmulgee River to be "a blend of *agassizi* and *aspera* with slight *ferox* admixture." Our specimens from between the Satilla and Ocmulgee rivers are quite similar to north Florida *ferox*, exhibiting no characters which we can attribute to the influence of *agassizi* or *aspera*. Stejneger (1944: 38, 42) listed and described a specimen of *ferox* (USNM 56804) from Irwin County, Georgia. We examined the specimen and fully agree with his identification. Unfortunately, specific locality data are not given, and it may have come from in or between any of three stream drainage systems (Alta-

maha-Ocmulgee, Satilla or Suwannee) which enter or closely approach Irwin County.

We have tried without success to obtain soft-shelled turtles from the Ocmulgee River but have observed sunning individuals in numbers at relatively close range, one from within about 5 feet. We are fully in accord with Neill (*loc. cit.*) that they were "mostly indistinguishable from *aspera* of the nearby Flint River." We were able to get close enough to some examples to see not only the light yellow-brown carapace color, which is evident at a considerable distance, but also the small carapace spots characteristic of the young of both *aspera* and *agassizi*. On the basis of our specimens of typical *ferox* from nearby lentic situations, we conclude that there is no intergradation between it and the *aspera-agassizi* populations in this area which lies a short distance to the east of the limits of the range of typical *aspera*[1].

The eastern boundary of the range of *aspera* may be said to include the Flint River in the Piedmont of Georgia, and the Ochlocknee River, lying east of the Flint, in the Coastal Plain of southwest Georgia and west Florida. The northern and western limits of the range of *ferox* remain as defined by Carr (1952: 413) "Florida, westward to the Apalachicola River and northward into southern Georgia. . . ." More specifically it can be said that *ferox* is known to extend westward into Leon and Wakulla counties of western Florida, northwestward into Baker and Decatur counties of southwestern Georgia, and northward into Wilcox County, central-southern Georgia. In all probability, the northward limit will be found, in time, to approach more closely the Fall Line or lower perimeter of the Piedmont. There is also little reason to believe that the western limits of *ferox* do not extend beyond the presently recognized boundaries.

Although *aspera* has been taken in lentic situations, it is essentially a fluviatile form (Goin, 1948: 304; Carr, *op. cit.*: 433). Within the range of *ferox*, we know of no specimen of *aspera* collected in a pond or lake other than one closely associated with a stream, as, for example, an ox-bow or other flood plain pond, or impounded water. On the other hand, *ferox* has been described as the least fluviatile of North American soft-shelled turtles although in Florida it is known to inhabit "streams, lakes, big springs and canals alike" (Carr, *ibid.*: 417). In areas between or adjacent to streams inhabited by *aspera*, we have records of *ferox* only from lentic situations. Thus, it appears that, in the area of geographical overlap between the two subspecies, i.e., between and near the Apalachicola and Ochlocknee rivers of Florida and the Chattahoochee, Flint, Ochlocknee, and Ocmulgee rivers of Georgia, *aspera* is nearly always an inhabitant of fluviatile situations whereas *ferox* is equally closely confined to non-fluviatile lakes and ponds. In general the two forms can be said to be sympatric in the broad geographic sense, but allopatric in a microgeographic or ecological sense. The separation is almost certainly not complete, since the two forms must have distributed themselves, to reach their present limits, by one or each form passing through the habitat of the other. We may expect, then, an occasional record of *ferox* from an *aspera*-inhabited stream or the infrequent occurrence of *aspera* in a *ferox* pond or lake.

We have indicated above that a continuous zone of intergradation between the two subspecies does not occur, and that they do overlap geographically. This conclusion is based on the collection of series and individual specimens of typical *ferox* from a number of localities along and northwest of the southeastern boundary of the range of *aspera*.

It is, of course, impossible to establish that there is no intergradation of any sort between the two forms. We have seen no evidence of genetic intermixture and we believe that our work represents a more critical study of the soft-shelled turtle populations in the area involved than has been carried out previously. Nevertheless, intergrades were reported by Neill (1951: 12), and, although we question the criteria used in the determination of these specimens, we have not seen the material and can hardly write conclusively respecting them.

Assuming for the moment that *aspera* and *ferox* are not reproductively isolated, an interesting possibility presents itself. Although the two forms are sympatric in a broad geographic

[1] After submitting this paper for publication, a female soft-shelled turtle was collected by Hopkins from the Ocmulgee River below Abbeville, Wilcox County, Georgia. The markings and cone-shaped tubercles of the carapace, and widths of carapace (246 mm.) and head (43 mm.) are typical of *aspera* and *agassizi* and in no way suggest *ferox*.

sense, as reproductively isolated but closely related species often are, they are allopatric in an ecological or microgeographic sense. It is generally agreed that intergrading subspecies must be allopatric, either ecologically or geographically, with the zone of intergradation occurring along their mutual boundary or boundaries. In the present situation, we have shown that there is not a single continuous mutual boundary along which a zone of intergradation could occur, but there do exist a number of situations in western Florida and southern Georgia where lakes and ponds grade into, or join abruptly with, streams. If intergradation does occur between *ferox* and *aspera*, it seems most likely that it would occur at or near the junction of the lentic and lotic environments. Again, we have seen no evidence that such intergradation does occur and it seems best on the basis of our observations to assume that it does not. Whether this assumption is correct or not, *aspera* intergrades with *agassizi*, which in turn intergrades with *ferox*, according to Neill (*ibid.*: 11–2). Thus, the taxonomic status of *aspera* and *ferox* is not altered by the present studies.

Neill (*ibid.*: 17) postulated the divergence of *ferox* and *aspera-agassizi* stocks while the former was isolated on a Pleistocene Florida island or archipelago. Subsequent connection of such an island or island group with the mainland, resulting from a lowering of sea level, would have permitted the geographic overlap of island and mainland stocks. Whether the two stocks had already diverged sufficiently, at their original meeting, to preclude the possibility of general genetic intermixture, or whether this developed subsequently cannot as yet be intelligently considered.

The ontogenetic variability of soft-shelled turtles and the distortion of characters in preserved material has been mentioned by most students of the group (Stejneger, 1944: 12; Conant and Goin, 1948; 3, 6; Neill, 1951: 8, 9; Carr, 1952: 417, 421, 432). We have gone to some length to determine at least a few characters which may be of value in the separation of specimens of *ferox* and *aspera* regardless of size, and our efforts have not been totally unrewarded. Although dried, warped and fragmental specimens still present a problem, at least most of the reasonably well preserved (in alcohol or formaldehyde) examples may be allocated with certainty to one or the other subspecies.

We have examined something in excess of 50 examples of *ferox* of representative sizes from Florida, in and south of the Suwannee and St. Marys drainage systems and have never found a cone-shaped, pointed or spiny tubercle along the anterior margin or elsewhere on the carapace. In hatchlings, as in full grown males and females alike, prominent tubercles of the anterior margin of the carapace have the form of flattened hemispheres (Fig. 2). Less prominent tubercles are simply more flattened. These tubercles may be seen in photographs figured by Stejneger (*op. cit.*: pls. 7, 9, 16a), Pope (1939: pls. 94, 95) and Carr (*op. cit.*: pl. 73). Tubercle shape in those specimens from the ponds and lakes of south-central and western Georgia and western Florida is identical with that of other Florida specimens. In the *aspera* examined by us—nine from the Apalachicola River system, five from the Etowah River and two from the Pearl River in Mississippi (USNM 95193-4)—there are always present some tubercles along the anterior carapace margin which are cone-shaped or at least pointed. In our smallest individuals such tubercles are flattened, but definitely pointed, cones. In the largest examples, the tubercles are long, pointed spines (Fig. 2; see also Stejneger, *op. cit.*: pl. 17). A dissecting microscope or hand lens may be required to determine tubercle shape with certainty in some hatchlings or very young turtles, but the unaided eye is usually sufficient. Stejneger (*ibid.*: 62) may be inadvertantly responsible for the infrequency of use of spine shape in separating *aspera* and *ferox* by his description of the tubercles on the edge of the carapace of two young male *aspera* (USNM 95193 and 95194) as "small" and "blunt." They are relatively so when compared, as Stejneger did, with the spines of two larger females; however we have examined the two specimens in question, now dried skins, and find that the tubercles actually are flattened and pointed spines. Probably in life they were more cone-shaped and, possibly, less conspicuously spiny.

The pattern of distribution of tubercles over the anterior carapace flap in young *ferox* is quite different from that found in young *aspera*.

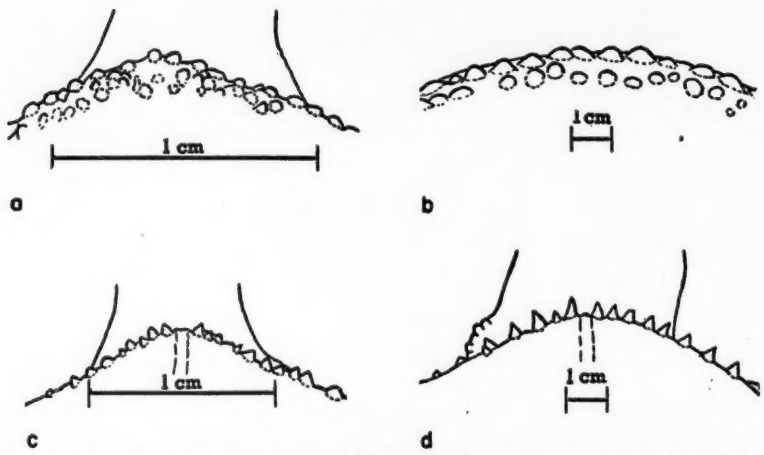

Fig. 2. Shape of the tubercles along the anterior margin of the carapace in *Trionyx ferox ferox* and *T. f. aspera*. a.—juvenile *ferox*, carapace length 4.3 cm.; b.—adult female *ferox*, carapace length 36.2 cm.; c.—juvenile *aspera*, carapace length 4.4 cm.; d.—adult female *aspera*, carapace length 30.3 cm.

In *ferox*, tubercles tend to trail along the carapace margins farther posteriorly than they do in the central part of the upper shell, forming a crescentic pattern, concave posteriorly. Laterally, the posteriormost tubercles occur at about the level of the axilla. In *aspera* the posteriormost tubercles occur at about the same level along the margins and in the central part of the carapace. Although most *ferox*, with increase in size, retain the crescentic pattern of tubercle distribution characteristic of the young, adults of *aspera* often develop posteriorly trailing tubercles in the central part of the carapace and along the margins.

The longitudinal ridges and rows of tubercles on the carapace of *ferox* are very helpful in the confirmation of identification of this form, often even in hatchling turtles. However, there is a tendency in *aspera* to develop longitudinal rows of tubercles with increase in size, and confusion may result if much weight is placed on this characteristic. The contrast between the carapace ridge development in the two subspecies is striking if specimens of similar size are compared. We have found no appreciable difference in the development of tubercle rows between southern Georgia examples and Florida specimens of *ferox*.

Among the most obvious differences between the two subspecies are general head and body dimensions (Figs. 3 and 4). In specimens of equivalent carapace length it is evident that *ferox* has a wider head, narrower carapace, and greater shell height. The carapace is subject to much distortion not only in well preserved material but in living individuals. Owing to the flexibility of the anterior and posterior portions of the shell, it is difficult to obtain accurate length measurements even of nearly perfect specimens. However, the writers, working independently but employing the same technique, have been able to obtain carapace length measurements of the same turtles that differed by less than 2 percent. Our method, admittedly somewhat subjective, involves lifting the anterior and posterior carapace flaps to as nearly a lifelike conformation as possible and taking the greatest straight line measurement between the anterior and posterior carapace margins. The shell height measurement is also somewhat variable depending chiefly upon whether the specimen has its head in or out, or is dehydrated, or swollen by preservative. In spite of the variation of these shell length and height measurements, when plotted against shell width, average differences between the two subspecies are easily observed, although some overlap is evident (Fig. 3).

The carapace width and head width are measurements subject to but slight variation. The ratio of these two relatively stable measurements affords a practical means of differentiat-

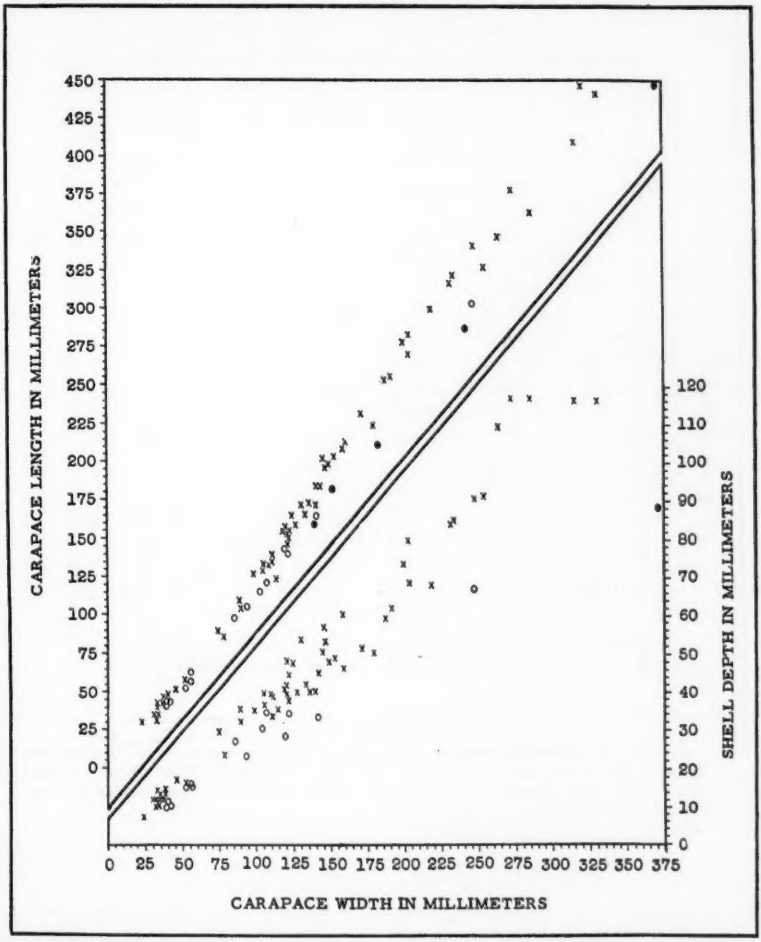

Fig. 3. Relationship of carapace width to carapace length (above) and carapace width to shell depth (below) in *Trionyx ferox ferox* and *T. f. aspera*. Circles represent examined specimens of *aspera* and solid spots are based on published measurements. Crosses represent examined specimens of *ferox*.

ing the two subspecies at all sizes. A scatter diagram of these measurements of *aspera* and of northern Florida and southern Georgia *ferox* shows no overlap between the two forms (Fig. 4). Measurements of nine specimens from the level of Lake Okeechobee and southward suggest that in southern Florida *ferox* has a greater carapace width, relative to head width, than it does in the more northern parts of its range. Mr. David Leake of Palatka, Florida has been kind enough to confirm this indication with his measurements of more than a hundred specimens from Lake Okeechobee. Thus, *ferox* from southern Florida is more similar to *aspera* in the ratio of head width to carapace width than is *ferox* from northern Florida. Even so, overlap of *aspera* and *ferox* from southern Florida is slight. (Since we are primarily concerned with the differentiation of *ferox* and *aspera* in their area of overlap, we have excluded our few measurements of southern Florida material from Fig. 4.)

That the carapace color patterns of young *aspera* and *ferox* serve as a means of positive

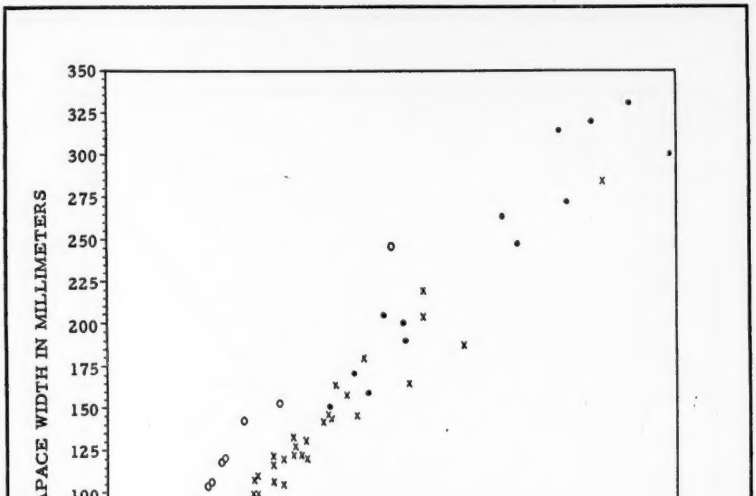

Fig. 4. Relationship of carapace width to head width in *Trionyx ferox ferox* and *T. f. aspera*. Circles represent *aspera*. Solid spots represent *ferox* from south of the Suwannee River; crosses represent it from north and northwest of the river.

identification has long been recognized. According to a description by Carr (1952: 416–7) of the young of *ferox*, "The carapace is yellowish olive with dusky spots and a narrow, well-defined, yellowish outer edge. These spots are so large that the narrow light lines separating them, in reality the background, appear to be a reticulated light pattern." The reticulated type of carapace pattern is evident in a young specimen from Gainesville, Florida, figured by Pope (1939: pl. 95). Stejneger (1944: pls. 19a and b) figured two juvenile examples from the Okefenokee Swamp in southeastern Georgia and from Auburndale in central Florida, having smaller light-centered blotches and wider areas of the light ground color showing. We have seen this latter type of coloration in specimens from Lake Okeechobee in south central Florida and from Royal Palm Hammock in extreme southwestern Florida. Although some hatchlings have the small blotched pattern, several that had a reticulate large-blotched one subsequently developed relatively smaller, light centered blotches after several months in an aquarium.

In young *aspera* the carapace ground color varies from light brown to yellowish-tan with from 48 to 102 (av. 64.8, based on a sample of 13 specimens from the Etowah River and the Apalachicola system) dark brown or black, subcircular solid spots or ocelli. Occasionally each dark spot is in the middle of a larger, ragged-edged, slightly less dark blotch. Usually two dark lines are situated adjacent to the posterior edge of the carapace and anteriorly along the lateral edges. Occasionally there is but a single line present. One of five specimens from the Etowah River in northwestern Georgia was so marked, but eight specimens from the

Apalachicola drainage system in which the carapace pattern is still visible had at least two marginal lines. The outer or posteriormost line is usually the more nearly complete although it may be broken in several places. The innermost line is frequently made up of disconnected segments, rows of small spots or combinations of both. Small spots forming part of a line are often almost identical to other carapace spots.

The largest living *aspera* examined that shows the typical juvenile pattern (UGC 145–4) is a male 143 mm. in carapace length from the Etowah River. The two posterior lines are virtually complete and segments of a third inner line are present. The solid, subcircular carapace spots range from about 1 to 8 mm. in greatest diameter with a general tendency for larger spots to be more centrally located. Two males from the Pearl River in Mississippi (USNM 95193 and 95194) retain the juvenile pattern although they are of even larger size, being 180 mm. and 158 mm. in carapace length, respectively, according to measurements taken by Stejneger (1944: 62) when the specimens were of a more normal shape than in their present dry and inflexible condition. The fact that all of these examples are males suggests that in *aspera*, as in *T. f. spinifera*, they may retain juvenile markings longer than the female (Carr, 1952: 428). Neill (1951: 21) felt that "small, subcircular blotches rather than ocelli" in *aspera* represent "attenuated *ferox* characters." We feel that the evidence does not warrant such a conclusion. The Etowah River male described above was taken almost 250 miles from the nearest known *ferox* record and almost 150 miles above the Fall Line of Georgia where natural, nonfluviatile lakes and ponds are virtually nonexistent.

Most *aspera* over about 100 mm. in carapace length have, in addition to the very dark, small, subcircular spots and ocelli, larger and less dark, ragged-edged blotches. As mentioned above, some very young turtles show such blotching. From the more frequent appearance of the larger, asymmetrical blotching in larger turtles, it seems reasonable to infer that such is usually secondarily developed. In all specimens of *aspera* less than 170 mm. in carapace length, if secondary blotches were developed, the primary symmetrical spots and ocelli could also be found within them. Primary spots and ocelli appear to grow very little if at all, relative to the size of the turtle. Secondary blotching develops around primary markings and apparently becomes more and more extensive with age. In the largest *aspera* examined (USNM 134249), a female of 302 mm. carapace length, extensive secondary blotching has not produced a unicolored carapace but, rather, a camouflage effect of extensive patches of brown of slightly different shades. Primary blotching cannot be recognized with certainty except for remnants of the posterior marginal lines.

The smallest *aspera* in which secondary blotches had begun to anastomose is a female of 121 mm. carapace length (UGC 145–1). In a female of 140 mm. carapace length (USNM 134243) very few secondary blotches are still completely isolated, the majority having expanded sufficiently to come in contact with other blotches. Primary spots are still recognizable in this specimen.

The dorsal surface of the neck and head, posterior to the eyes, often follows a change in color pattern similar to that of the carapace. Primary small dark spots and dashes are present in young turtles. Secondary blotches develop around the primary markings about the same time that they appear on the carapace and continue to expand as the turtle grows. In the largest *aspera* examined, primary spotting on the head and neck is still evident.

In contrast, in young *ferox* the color patterns of the carapace, neck and head, posterior to the eyes, consist essentially of large dark, smooth-edged blotches with little ground-color in evidence between (see above). With increase in age, these blotches decrease, if anything, relative to the size of the turtle. The pattern apparently becomes obscure by a decrease in contrast of blotch and ground color, rather than by an increase in size of blotches. Thus in some fairly large specimens, smooth-edged blotches on a slightly lighter ground color can be made out. One example from the St. Johns River, Clay County, Florida (UGC 143) has a surprisingly clear pattern for its carapace length of 269 mm.

Conant and Goin (1948: 2) reported that, in *aspera*, the postocular and postlabial light lines usually meet on the sides of the head. Although it has not been possible to determine the configuration of head stripes in every individual,

postocular and postlabial stripes join on at least one side of the head in five turtles from the Etowah River and in five of eight from the Apalachicola drainage system. Of the three Apalachicola turtles in which the head stripes could not be observed to join, they clearly remain separate in one; in another they tend strongly to join but fade out at the point where junction would be expected; in the third, a large female, the stripes appear not to join but are too faded to be followed with certainty.

Neill (1951: 10) reported that in about 80 percent of the *aspera* he examined, the continuation of the postocular stripe along the neck had a dark upper border only. Of the specimens examined by us, all five from the Etowah River and five of the nine from the Apalachicola drainage system had dark borders above and below the postocular stripe from the orbit well out along the neck. Although our sample is small, we suspect that the absence of a postocular lower border may be correlated with size. Our four smallest specimens (USNM 134244–5 and UGC 146-1 and -2), ranging from 42.1 mm. to 54.3 mm. in carapace length all lack the lower dark border, whereas in larger ones, from 56.5 mm. to 302 mm. in carapace length, a dark lower border is always present along the neck. In the largest *aspera* examined, the postocular stripe fades rapidly posterior to the head, but the upper and lower postocular borders fade at about the same level.

The light lateral head and neck bands of juveniles of *ferox* contrast more sharply with the ground color and are more numerous than in *aspera*. The postocular band in *ferox* angles downward more sharply than in *aspera* and is rarely continuous with the dorsalmost lateral neck band. The postlabial band usually angles ventrally, posterior to the angle of the jaw and, not infrequently, proceeds forward a short distance on the chin. Usually the postlabial is not in contact with a ventrolateral neck band.

The ventral shell surfaces of hatchlings of *ferox* are slate gray, often with limited light spotting on the ventral carapace surface and on the anterior plastral flap (Carr, 1952: 417). In contrast very young *aspera* are frequently uniformly white beneath. In many, vague dark wavy lines are present along the posterior ventral carapace surface. With increase in size, *ferox* may become uniformly light beneath, thus closely approaching *aspera* in this respect. More often there is dark spotting on the posterior ventral carapace surface of a more extensive nature than is found in *aspera* and, occasionally, a diffuse dark mottling is present over most of the plastron.

For permission to examine specimens in their care, we are grateful to Dr. Archie F. Carr, of the University of Florida; Dr. Doris M. Cochran, of the United States National Museum; and Dr. Bernard S. Martof, of the University of Georgia.

For the gift of material or for assistance in the collection of specimens, we are greatly indebted to the following: Drs. J. C. Dickinson, J. H. Gregg, H. T. Odum and Messrs. C. T. Adams, Walter Auffenberg, Keith Hansen, P. G. Pearson and W. C. Sloan of the Biology Department, University of Florida; Dr. R. E. Bellamy of the U. S. Public Health Service Encephalitis Laboratory, Bakersfield, California; Dr. J. D. Burke of Richmond College, Richmond, Virginia; Dr. H. W. Deurloo of the University of Florida Infirmary; Mr. Robert Humphries of the Savannah River Project, Atomic Energy Commission, Jackson, South Carolina; Mr. David Leake, Palatka, Florida; Mr. W. T. Neill, Research Division Ross Allen's Reptile Institute, Silver Springs, Florida; Mr. George B. Rabb, University of Michigan Museum of Zoology; Dr. George J. Schumacher, Cornell University and Mr. L. E. Turner, Veneta, Oregon.

We are especially grateful to Mr. Roger Conant, of the Zoological Society of Philadelphia, Drs. Archie F. Carr, Coleman J. Goin, and Mr. Walter Auffenberg of the University of Florida, and to Dr. R. E. Bellamy for inspiration and for patient criticism of ideas and manuscript.

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The Use of Morphometric Data in Systematic, Racial and Relative Growth Studies in Fishes[1]

JOHN C. MARR

MORPHOMETRIC data have, for obvious reasons, been employed widely in both the "old" and the "new" systematics, in the study of races or subpopulations of fishes and, somewhat more recently, in the study of the relative growth of body parts. The methods of handling such data have been far from uniform and, in addition, have led to the incomplete extraction of information from a given set of data or, in some instances, to erroneous conclusions.

In systematic studies, for example, body dimensions are usually expressed in per cent or per mille of standard length, often as averages (i.e., without respect to absolute standard length). Only rarely are the original measurements included. Even more rarely are regression techniques employed. When they are used, one is more apt to find the regression of "body part in per mille of standard length" on standard length than the regression of original variates. There are several possible reasons for these practices. One reason, and perhaps the main one, is merely historical precedent. A second reason is that often only one or a few specimens are available to the systematist and other methods are not appropriate. A third possible reason is that a lack of appreciation of variation and/or size-specific changes leads to the use of the convention. A fourth reason perhaps, is that even though a large series of specimens is at hand, the systematist may not be aware of the convenient methods which are available for treating morphometric data.

Racial or population studies based on body proportions are usually carried out by fishery biologists and, in general, are usually based on larger series of specimens than are conventional systematic works.[2] Racial studies generally, although not always, use the original variates and take advantage of the many conveniences of regression techniques.

Students of relative growth seem to have been the most progressive in the use of the appropriate statistical tools. One reason for this may lie in the fact that such workers have been interested not only in the manifestations of the relative growth of body parts, but also in the nature and causes of such growth.

Perusal of the literature and discussions with many interested individuals lead me to the conclusion that the wider use of regression analysis (of original measurements) would contribute materially to solution of the general types of problems mentioned above and, paradoxically, the use of such analysis (using ratios) has in the past led to confusing or doubtful conclusions. It is my hope that the following discussion will help to make the potential benefits evident, as well as to point out the various pitfalls to be avoided. It is my thesis

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[2] I distinguish between systematic and racial studies, not because of any inherent differences in the two, but rather because of the philosophical differences in approach to the problems. It seems a fair generality to state that the fishery biologist is inclined to realize that he is studying a dynamic situation in nature involving rather complicated sampling problems, whereas such inclination is apt to be much less pronounced in the systematist. Myers' (1952) comments are relevant.

(1) that the use of original measurements, rather than ratios, is time saving, easier to interpret, and less likely to lead to confusing conclusions and (2) that in the use of regression analysis of original measurements, the types of regression equations are not always used to best advantage, nor are their peculiarities fully appreciated.

Types of Regressions

The concept which makes regression techniques of value in morphometric studies is that the size or growth of one variable, say a body part, is related in a particular way to the size or growth of another variable, say the entire organism. If the form of the relationship and the size of the organism are known, it is possible to predict, within definable limits, the size of the body part. As a corollary, it is possible to distinguish individuals in which the relation of body part to organism exceeds the expected limits or takes a different form and which, therefore, must have been drawn from a different population with regard to this attribute.

Fortunately, it so happens that the relationship of part to whole may usually be represented by one or another of a few general equations. It also happens that, for those equations which are not rectilinear, it is often easy to make rectilinear transformations. Convenient methods have been worked out for characterizing and comparing rectilinear regressions and have been described in many statistical textbooks. (These methods have certain limitations in the case of small differences; see comments by Schaefer (1952).)

In discussing the various kinds of regressions, let us consider only the three forms to which the relationship of body part to body length most commonly conform.

The *rectilinear regression* may be expressed by

$$y = a + bx \quad \ldots\ldots (1)$$

where y = the dependent variable (say length of body part); x = the independent variable (say body length); a (a constant) = the y-intercept or the value of y when $x = 0$; and b (a constant) = the slope of the line or the constant absolute change in y per unit change of x. Lines corresponding to (1) will always form a straight line on arithmetic coordinates.

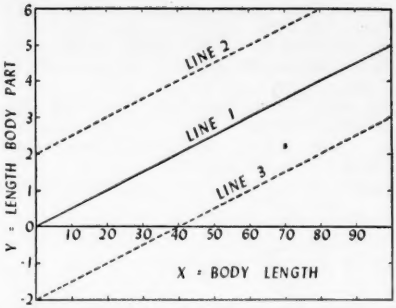

Fig. 1. Hypothetical examples of rectilinear regressions of the type $y = a + bx$.

An example of a rectilinear regression is given as line 1 in Fig. 1. Note that, in the example given, a unit change in x produces $\frac{1}{20}$ of a unit change in y, $b = .05$, and also that the line passes through the origin ($y = 0$, $x = 0$), $a = 0$. The equation for this line may be written

$$y = .05x$$

or, more generally

$$y = bx \quad \ldots\ldots (2)$$

The *power regression* or "allometry equation" may be expressed

$$y = cx^k \quad \ldots\ldots (3)$$

where y and x represent the two variables as in (1); k (a constant) is the constant percentage that each y-increment is of the preceding increment; and c (a constant) is the slope of the tangent to the curve when $x = 1$. (The magnitude of c depends on the units of measurement; it is an arbitrary constant.) Note that the curve will always pass through the origin, since if $x = 0$ the right side of (3) becomes zero and $y = 0$. Lines corresponding to (3) will always form a straight line on logarithmic coordinates and, except in special cases, a curve on arithmetic coordinates.

Obviously, (2) is a special case of (3) where $k = 1$.

Transformation of (3) to logarithms yields

$$\log y = \log c + k \log x \quad \ldots\ldots (4)$$

which is of the same form as (1), with $\log c = a$ and $k = b$.

An example of a power regression is given in Fig. 2. In the example, $c = 0.2$ and $k = 0.9$. This curve is convex; y is growing at a

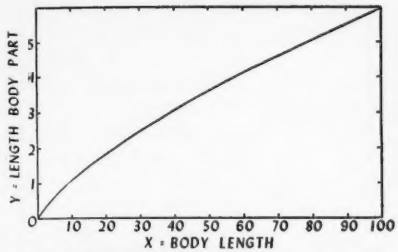

Fig. 2. Hypothetical example of a power regression of the type $y = cx^k$.

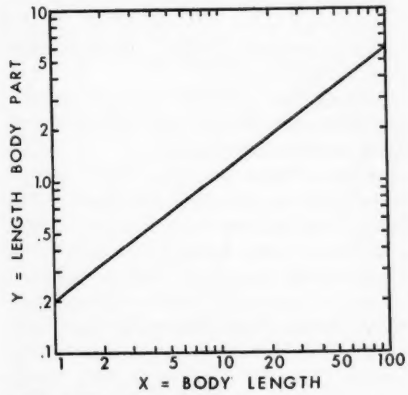

Fig. 3. Hypothetical example of a power regression of the type $y = cx^k$.

slower relative rate than is x. If $k > 1.0$, the curve is concave; y is growing at a faster relative rate than is x. If $k = 1$, the curve is a straight line.

The same curve is plotted on logarithmic coordinates in Fig. 3. (It is usually easier to plot directly on log paper, rather than to look up the logarithms and plot their values on arithmetic coordinates.) In this transformation, k = the slope of the line. A slope of 1.0 (i.e., at 45° to the x-axis) indicates a curve whose equation is represented by (2). When $k > 1.0$ the angle of the curve to the x-axis will exceed 45°.[3]

The general expression which may be written to include (1) and (3) is

$$y = a + cx^k \quad \ldots\ldots (5)$$

[3] As Morrow (1952) and others have pointed out, when the dependent variable involves two dimensions (such as breadth and depth) a 45° curve on logarithmic coordinates will result when $k = 2$. Similarly, when the dependent variable involves three dimensions, a 45° curve will result when $k = 3$.

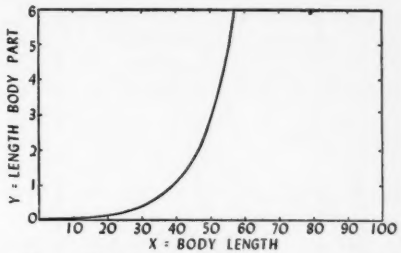

Fig. 4. Hypothetical example of an exponential regression of the type $y = pe^{kx}$.

In the case of (1) $k = 1$ and in the case of (3) $a = 0$.

The *exponential regression* may be represented by

$$y = pe^{kx} \quad \ldots\ldots (6)$$

where y and x represent the two variables as in (1) and (3); p (a constant) = y when $x = 0$; e is the base of natural or Napierian logarithms; and k (a constant) is the percentage change in y per unit change in x. Lines corresponding to (6) will always give a straight line on semi-logarithmic coordinates and a curve on arithmetic coordinates. Equations of type (6) may be recognized as the "compound interest law."

Transformation of (6) to logarithms yields

$$\log y = \log p + k(\log e)x \ldots (7)$$

which is, again, of the same form as (1), with $\log p = a$ and $k \log e = b$.

An example of a curve of the type (6) is shown in Fig. 4 on arithmetic coordinates and in Fig. 5 on semi-logarithmic coordinates. In the example $p = 0.02$ and $k = 0.1$. Note that the log scale is on the y-axis.

Relationships of this form are relatively uncommon and obviously could not obtain over a large range of x-values, since the body part would eventually become exceedingly larger than the body.

The exponential relationship is more commonly encountered in the form

$$x = pe^{ky} \quad \ldots\ldots (8)$$

But since one is interested in estimating y from x, this may be re-written as

$$y = \frac{-\log p}{k(\log e)} + \frac{1}{k(\log e)} \times \log x \ldots (9)$$

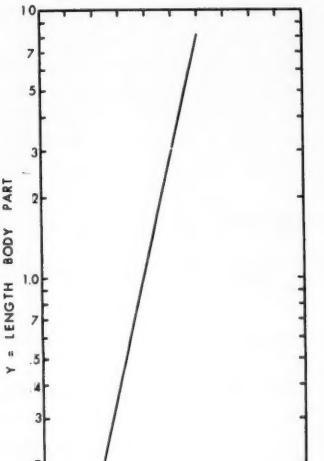

Fig. 5. Hypothetical example of an exponential regression of the type $y = pe^{kx}$.

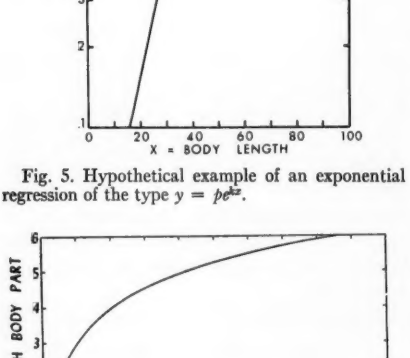

Fig. 6. Hypothetical example of an exponential regression of the type $x = pe^{ky}$.

Here the log scale is on the x-axis.

Again, this is the form of (1), with $\frac{-\log p}{k(\log e)} = a$ and $\frac{1}{k(\log e)} = b$. Also, since $e^0 = 1$, when $y = 0$, $x = p$. The curve cannot go through the origin unless $p = 0$ and in that case (8) would reduce simply to

$$x = 0$$

The curve (8) is, in fact, asymptotic to the y-axis.

An example of a curve of form (8) is given on arithmetic coordinates in Fig. 6 and on semi-log coordinates in Fig. 7. In the example $p = 1.0$ and $k = 0.75$.

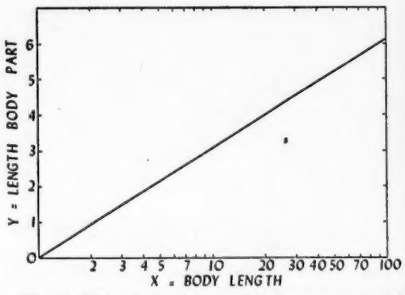

Fig. 7. Hypothetical example of an exponential regression of the type $x = pe^{ky}$.

Judging from published data, the relationship of size of the body part to body size in fishes will generally approximate very closely equations of either type (1), (3) or (8). (Although this discussion has been restricted to fishes, it is well known that the methods discussed are widely applicable to both vertebrates and invertebrates.) Further discussions which are pertinent to this, or closely allied problems, have been given by Barnes (1952), Brody (1945), Child (1941), Huxley (1932), LeGros Clark and Medawar (1945), Martin (1949), Simpson and Roe (1939), Thompson (1943) and Winsor (1946).

While there has been rather wide use of the "allometry equation," (3), especially in relative growth studies, its use has been largely empirical. So far as I have been able to discover, there has been no satisfactory theoretical explanation of why the relative growth of body parts should follow any of the regression equations given above, or any other for that matter (but see von Bertalanffy, 1949). The significance of these observed relationships is not germane to discussion of appropriate methods of representing empirical data. However, I believe a promising approach to this fundamental problem of relative growth could be made under the reasonable assumption that the juveniles, for example, and the adults of any particular species are well suited for existence in their respective environments. Considering these two known forms (juvenile and adult), with differing body proportions, as fixed "beginning" and "end points", the vari-

ous ways by which the necessary changes in body form could be accomplished could then be investigated.

While perhaps not strictly pertinent to this discussion, any description and interpretation of relative growth data should take into account the following: (1) The data may be representative of phenotypes rather than genotypes (Martin, 1949; Tåning, 1952). (2) Length, which is commonly used as a measure of size, represents only one dimension and may, therefore, not be the best measure of size. (3) Various life history stages may involve different growth stanzas.

Ratios vs. Original Measurements

Examples of dubious conclusions or, at the very least, incomplete utilization of data, arising from the use of ratios rather than original measurements are to be found throughout the literature. Before proceeding to some of these, I should like to provide a hypothetical example. For the sake of simplicity I shall restrict the example to data forming a rectilinear regression of type (1).

The example previously used, shown as line 1 in Fig. 1, has a slope of 0.05 and passes through the origin. Also shown in Fig. 1 are two additional lines having the same slope as line 1, but with one having a y-intercept of $+2$ (line 2) and the other having a y-intercept of -2 (line 3). The lines of this family differ only in intercept; they all represent the same change in y per unit change in x. (In actual practice, one is often considering only a sample drawn from a range of adult sizes. In such a case the y-intercept and the slope of the line, b, are parameters of the regression for *only* that size range sampled. The use of the y-intercept as a parameter should not be taken to imply that the regression is extrapolated back to estimate the size of the body part when body size was zero.)

The three main features of these lines (rectilinearity, intercept differences and identity of slopes) are apparent when they are plotted in this form. Furthermore, there are conventional methods of characterizing such lines, for defining variance and for comparing lines (see Snedecor, 1946 and Kendall, 1948, for example). This is not true when ratios are used.

The three lines of Fig. 1, are shown again in Fig. 8, but in the latter figure, the ratio "length of body part/body length" is plotted as the dependent variable and body length is plotted as the independent variable. In line 1, y increases at the rate of 0.05 x and this is reflected in the horizontal line at 0.05. Lines 2 and 3 also increase at the rate of 0.05 x, but do not form a horizontal line in the ratio plot. They have large positive (line 2) or negative (line 3) values for small values of x and decrease in absolute magnitude as x increases. They are in fact, asymptotic to the horizontal line at 0.05. The deviation, in the ratio plot, of lines 2 and 3 from line 1 arises from the fact that they do not pass through the origin. Their intercepts are, percentagewise, large when x is small and small when x is large. For some purposes, identification of specimens for example, it would be pertinent to observe that in the species represented by line 2 the length of body part relative to body length does decrease with increasing body length. But this is solely the effect of the positive y-intercept and it would be inaccurate to conclude that the rate of change in size of body part relative to body length was decreasing. In the literature this "intercept effect" in ratio plots is often erroneously interpreted as indicating allometric growth.

The ratio plot does not yield any information which cannot be obtained from the plot of original variates, the curvilinearity (when there is an intercept differing from zero) makes difficult, if not impossible, the computation of variance and comparison of lines and, finally, a likely source of error in interpretation is introduced.

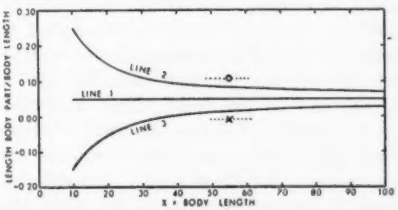

Fig. 8. Hypothetical examples of rectilinear regressions of the type $y = a + bx$, with the ratio y/x plotted as the dependent variable.

Some Examples

In systematic works, when only one or a few specimens are available, it is customary to present tables of data in which, for each specimen, the actual standard length is given, but all other measurements are expressed in per cent or per mille of standard length. Examples of such tables may be found in a paper by Schultz (1949). When small numbers of specimens are involved it is possible to present complete data (even if these are customarily given in the form of ratios), but it is impossible to make use of regression analysis simply from lack of data. However, even when large series of specimens are available it often happens that only a few are measured (see Table 22 in Schultz (1944), for example).

When large series of specimens are used it is generally impossible to present all data owing to space limitations, and some form of condensation is required. Even though the data may be represented concisely by regression equations and standard errors, one commonly finds tables in which the mean and ranges of the ratios are given. An example of such tables is Table III of Hubbs and Bailey (1940), which pertains to six forms of *Micropterus*. They give the means and ranges of ratios, but do not indicate the actual size of the fishes to which the ratios pertain (except for the mean and range for one subspecies). Many of these ratios are changing with increase in fish length, as they indicate, and the table is accordingly difficult to interpret.

The pitfalls of using arithmetic averages of ratios have frequently been described in numerous statistical texts. The average ratios for lines 2 and 3 in Fig. 8 are indicated by the short broken lines. Obviously, the average for line 2, for example, is below the true values at small fish sizes and above the true values at large fish sizes. The average ratio for average fish size exceeds the true value for line 2 (circle) and for line 3 (x). These anomalies are, of course, in this case the result of intercepts differing from zero. (However, when the size range in individual samples is small and when the small size range is essentially the same for all samples to be compared, the use of ratios will probably lead to the same conclusions as would the use of regression analysis.)

Parr (1949) has proposed a rather complicated system for representing body proportions of fishes with reference to growth changes. Without wishing to comment on the utility of his proposed system, I should like to point out that unnecessary complications have been introduced by the use of ratios. For example, in his Fig. 2c there are plotted the ratios of head length/standard length against standard length of *Alepocephalus girardi*. To these points he has fitted two straight lines with a break at about 600 mm. standard length. It seems likely that these points may be better fitted by a smooth curve similar to line 3 in my Fig. 8. In fact, if Parr's data are replotted as original variates, it is evident that the curvilinearity of the ratio plot is caused by the positive intercept, just as in line 3, Fig. 8. It may also be mentioned that the point which Parr considered to be anomalous in his plot is not anomalous in a curvilinear ratio plot nor in the rectilinear regression of original variates.

A series of papers on yellowfin tunas by Schaefer (1948, 1952) and Schaefer and Walford (1950) might equally well be considered as systematic or as racial studies. In addition to including all original data, these studies have made use of regression analysis of original measurements. Reference to these works will clearly demonstrate the objective advantages of the methods used. As a result of these studies, these authors concluded that the samples from off Angola, off Central America in the Pacific, and from the vicinity of the Hawaiian Islands represent distinct populations. The taxonomic question of the rank of these distinct populations was deferred pending further studies.

That the advantages of the methods of regression analysis are not universally appreciated is evidenced by Ginsburg's (1953) treatment of the yellowfin tunas. He elects not to use regression analysis and puts the data of Schaefer (1952) and Schaefer and Walford (1950) ". . . . in a form comparable to that usually employed in taxonomic treatises. . . ." (Ginsburg, 1953: 4); i.e., in the form of frequency distributions of ratios by selected length intervals. This, of course, is a kind of primitive regression analysis with none of the quantitative advantages of the methods used

by Schaefer and Walford. It does, however, represent an advance over the use of averages of ratios in that size-specific changes are recognized.

Mayr, Linsley and Usinger (1953: 137–8) stated that ". . . . ratios are more useful as taxonomic characters than direct measurements, because the variable factor of size is minimized. . . ." And, further, that "Care should be taken to check the rate of increase of each of the measurements used in a ratio, because different parts of the body of an animal commonly grow allometrically." In an example they give the ". . . . allometry is so slight that it does not affect the validity of the conclusions for taxonomic purposes. In some cases, however, allometry renders a particular pair of characters completely useless for taxonomic purposes." While they correctly point out that allometric growth vitiates the use of ratios in regression analysis, the use of original variates with appropriate transformation in regression analysis will not preclude the use of data involving allometric growth.

Racial studies generally involve larger series of specimens than does taxonomic research at higher systematic levels, and the opportunities to make use of regression analysis are consequently greater. Examples of the use of regressions of original variates may be found, in addition to some of the papers cited above, in the works of Godsil and Greenhood (1951) on Pacific yellowfin tuna, Kesteven (1942) on the Australian mullet, Roedel (1952) on Pacific mackerel and Wilder (1952) on brook trout.

Rounsefell (1930) has compared the head lengths of Pacific herring from different localities, by considering the regressions of head length/body length ratios on body length. These regressions are curvilinear and he interpreted the fact that the curves did not overlap as indicative of differences, since . . . . "the differences between the curves cannot be calculated mathematically owing to the differences in slope. . . ." (Rounsefell, 1930: 270). If the original variates are plotted, rectilinear regressions result which can be compared by the conventional methods. The curvilinearity of the ratio plots results, again, from the fact that the regressions of original variates have *y*-intercepts differing from zero.

As stated above, students of relative growth seem, in general, to have been aware of the limitations of ratios and to make use of the statistical tools available. Examples of such studies are those of Martin (1949) on various species, Morrow (1952) on striped marlin, and Shapiro (1943) on various scombroid fishes.

Morrow (1951), in studying the relative growth of the longhorn sculpin, has considered the regression of the body part/standard length ratio on standard length. With regard to the eye he stated (1951: 20): that it ". . . . shows a pronounced degree of negative allometry in the small specimens and slight negative allometry in the larger animals. This is of particular interest, for there is an abrupt change in the slope of the line of trend at about 80 mm. S.L., indicating that a marked change in the manner of growth of this organ occurs early in the second year. . . . Apparently the eye grows rapidly during larval and post-larval development and then slows abruptly, resuming growth at nearly the same rate as the rest of the body during the second year."

Actually, his ratio plot is fitted better by a continuous curve rather than by two straight lines. The regression of original variates proves to be rectilinear with a positive *y*-intercept. The latter, of course, accounts for the curvilinearity of the ratio plot. Therefore, the rate of growth of the eye in relation to the rate of growth of the body does not change over the size range studied. Dr. Morrow has kindly re-examined these data and has informed me (personal letter dated September 29, 1953) that he is in complete agreement with my interpretation.

Summary

The relation of size of body part to size of body in fishes will generally conform to either rectilinear, power or exponential equations. The latter two may be easily transformed to straight lines by the appropriate use of logarithms. For such straight-line regressions there are conventional methods of characterizing the lines, computing their variance, and comparing them.

Systematic studies and, to a lesser extent, racial and relative-growth studies often present data on body proportions in the form of ratios, averages of ratios, or regressions of ra-

tios. These methods, as opposed to the regression analysis of original variates, are inefficient and may often lead to erroneous interpretation. A simple hypothetical example, as well as several examples from the literature, demonstrates the point.

Acknowledgments

A number of individuals have read this paper in manuscript and I am indebted to them for their helpful suggestions and comments. They are: Rolf L. Bolin of Stanford University; Ernst Mayr of Harvard University; J. E. Morrow, Jr. of the Bingham Oceanographic Laboratory; M. B. Schaefer of the Inter-American Tropical Tuna Commission; G. G. Simpson of the American Museum of Natural History; and E. H. Ahlstrom, F. E. Felin, I. Ginsburg, D. L. McKernan, W. F. Royce, O. E. Sette and T. M. Widrig of the U. S. Fish and Wildlife Service. I also wish to thank J. E. Böhlke for preparing the figures.

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Pharyngeal Tooth Replacement in *Semotilus atromaculatus* and *Clinostomus elongatus,* Two Species of Cyprinid Fishes

HOWARD E. EVANS AND EARL E. DEUBLER, JR.

INTRODUCTION

TELEOST fishes usually have five pairs of branchial arches, four of which bear gill-rakers medially and gill lamellae laterally. Typically each arch consists of a hypobranchial, ceratobranchial, epibranchial and pharyngobranchial. Some marine and freshwater fishes have various branchial arches or parts of arches modified for tooth attachment. As a rule this modification is associated with the reduction or loss of teeth on the jaws. Cyprinid fishes, lacking teeth on the jaws, have a well developed dentition on the modified fifth branchial arches. The fifth arches in all Cyprinidae are represented by hypertrophied ceratobranchials, sickle shaped in appearance and joined at their ventral ends by a ligament which in older fish may ossify. They are located in the floor of the posterior pharynx, anterior to its junction with the esophagus and are usually referred to as the "pharyngeal arches".

The shape of the pharyngeal teeth varies widely between the species and various classifications of tooth forms have been proposed. One of the earliest major studies of pharyngeal teeth was that of Heckel (1842) who described thirteen forms under four major divisions. His major divisions were: (1) concave, (2) aggregated, (3) recurved with grinding surfaces, and (4) recurved without grinding surfaces. The most recent comprehensive study of the pharyngeal arches and their teeth is that of Chu (1935). He refers the teeth of cyprinids to three principal categories: compressed, depressed, and conical. The compressed teeth are further divided into six types while the depressed and conical teeth are each divided into three types. Heterodont dentition characterizes a few cyprinids such as the goldfish (*Carassius*) and the carp (*Cyprinus*), in which the first tooth is conical while the remainder are compressed (goldfish) or flat and ridged (carp).

The forms of teeth are correlated with the feeding habits of the species. In carnivorous cyprinids the teeth are pointed and slightly hooked so as to function primarily for holding and swallowing the prey. In herbivorous and omnivorous species a grinding surface is present for titurating the food. Some mollusc-eating minnows likewise have grinding molariform teeth.

A superficial examination of a preserved or fresh specimen with the teeth in situ may lead one to doubt the efficiency of this pharyngeal mill because the teeth lie hidden in folds of pharyngeal mucosa. However, after one listens to the feeding activity with a hydrophone and examines items of food recently passed to the stomach, there is little doubt that the teeth play an important role in feeding. Twenty captive chubs (*Semotilus*) fed mealworms singly were found to emit 6 to 67 chewing sounds with an average of 17 for each worm swallowed. An examination of the worm after it had been swallowed showed it to be lacerated along one side and slightly crushed by the action of the teeth against the dorsal horny pad. There are powerful muscles associated with the pharyngeal arches which move them in four principal directions. The teeth bite against a dense collagenous pad which rests upon the ventral surface of the basioccipital bone. For a recent discussion of the muscles of mastication in a cyprinid see Girgis (1952).

The number and arrangement of teeth on the arch is rather constant for the species of minnows. They are in either one, two, or three rows. The number of teeth on the inner row varies from 3 to 7, that of the middle row from 0 to 4 and that of the outer row from 0 to 2. After studying many of the world's cyprinid genera, Chu (1935) concluded that the primitive condition is represented by three rows of teeth with 5 on the inner row, 4 on the middle row and 2 on the outer row. In Asiatic and African cyprinids three rows of teeth predominate, whereas in European forms three rows are rare and in native North American species, three rows never occur except as an anomaly. When reduction in the number of rows takes place, it is the outer row which is lost first, followed by the middle row. The arrangement of the teeth on the arches is expressed by a formula which represents the number of teeth on the left arch followed by those on the right. The formula for *Semotilus* and *Clinostomus* is 2,5–4,2 which indicates that there are 2 teeth on each outer row, five teeth on the left inner row and four teeth on the right inner row. When two rows of teeth are present, as in the fish under consideration, it is customary to speak of the inner row as the major and the outer as the minor row.

Hubbs and Hubbs (1945), in reviewing bilateral asymmetry in fishes, pointed out that in several European species the number of teeth on the left side is greater than on the right and like asymmetry characterizes most if not all American cyprinids in which the number of teeth commonly vary from four to five. In *Clinostomus* a random sample of 150 specimens of one species all had the typical 2,5–4,2 pattern of functional teeth. A like sample of *Semotilus* exhibited eleven variations from the typical pattern. They were 2,6–4,3; 2,5–4,3; 2,5–5,2 and 2,4–5,2. Two of the eleven fish had three rows of teeth with a count of 2,5,2–1,4 and 2,5,2–2,4,2. The reason for the appearance of three rows of teeth in a species which normally has but two, can be explained by the failure of a functional tooth to fall out when its replacement ankylosed with the arch. Evidence for this (Fig. 1) is the excessive tooth wear which has resulted in the grinding off of the enamel tip exposing the dentine of major teeth 1 and 2 on the left arch and tooth 1 on the right arch. Soon one would expect to see a worn tip on tooth 2 of the right arch as a result of its prolonged use. On the left minor row, one tooth has been shed but a replacement has not as yet filled the socket. The absence of worn teeth on any other specimens of either *Clinostomus* or *Semotilus* indicates that normal tooth replacement is rapid enough to prevent the wearing off of the enamel tip on the functional tooth. It might be noted at this point that we have observed the flat, ridged, grinding teeth of the carp erupt as such from the pharyngeal mucosa. Thus the worn appearance of the grinding surface is not the result of use, and judging by the number of replacement teeth seen, it is doubtful whether a tooth in this

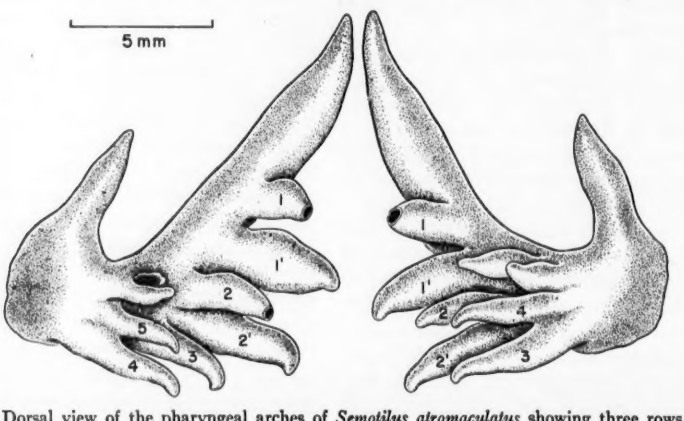


Fig. 1. Dorsal view of the pharyngeal arches of *Semotilus atromaculatus* showing three rows of functional teeth instead of the usual two.

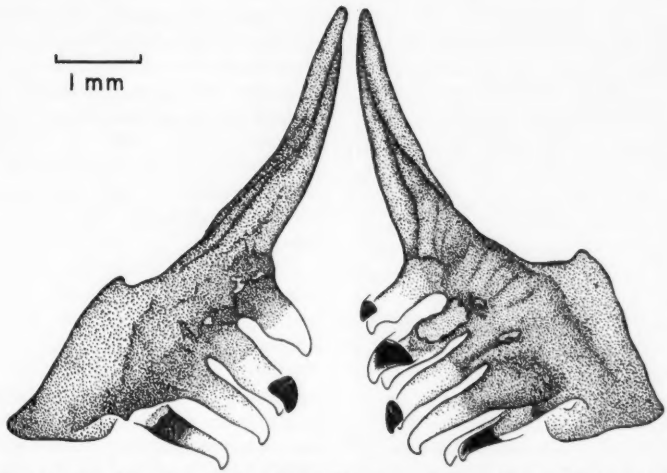


Fig. 2. Ventral view of the pharyngeal arches of *Clinostomus elongatus* showing the functional teeth and replacement teeth of the major row. (Left arch appears on right hand side of figure).

species remains functional for any considerable length of time.

The replacement teeth on cyprinid pharyngeals have been recognized for a long time. Jurine (1821) described them as being haphazardly arranged around the functional teeth. Owen (1840) in his extensive Odontography, evidently overlooked Jurine's work but supplied a good description of the structure of replacement teeth although little is said about their arrangement or succession. Belogurov (1940) examined young carp and noted a difference in both the relative size and shape of a given tooth for each successive replacement, as the fish increased in length. In larval carp he observed that the first functional tooth to appear on the inner row was the third, followed by the first and then the second. A fourth and more posterior tooth arose later than the other three teeth but was usually lost after two replacements. Evans[1] briefly described the position of replacement teeth in four species of cyprinid fishes.

In a typical vertebrate tooth the anlage of the enamel organ is oral epithelium and hence ectodermal in origin while that of the dentine organ is submucous mesodermal tissue. Edwards (1929) studied the question of the origin of the pharyngeal teeth in the carp and found that the enamel organs are derived from the deep columnar layer of pharnygeal epithelium. Therefore, they are endodermal in origin since this layer of the mucous membrane has been demonstrated to represent the original endodermal layer of the primordial foregut. The first evidence of an enamel organ in the carp is found four hours after hatching. The histological features of tooth replacement in *Semotilus* and *Clinostomus* will be dealt with in a subsequent paper.

From this brief introduction it may be noted that although replacement teeth of cyprinid fishes have been recognized for a long time, a pattern of succession has never been demonstrated. The alternate arrangement of similar-sized replacement teeth on each arch of *Semotilus* first suggested the existence of a replacement pattern. Thus the main objective of this paper is to establish and illustrate the fact that a definite order of tooth succession exists.

Materials and Methods

The fish chosen for this investigation, *Semotilus a. atromaculatus* (Mitchill) and *Clinostomus elongatus* (Kirtland), are widely distributed creek minnows having similar feeding habits and habitats. The 150 specimens of *Clinostomus* ranged from 37 to 79 mm. in standard length and were captured during May and June four miles south of Danby, New York. The 127

[1] Structural modifications correlated with feeding habits, in four species of cyprinid fishes. Doctoral thesis, Cornell Univ. 1950: 1–105.

TABLE I

CHI-SQUARE TEST OF THE HYPOTHESIS THAT THE PHARYNGEAL TEETH ARE REPLACED WITH EQUAL FREQUENCY

Arch Genus	Observed frequency occurrence of replacement teeth No.					X^2	Expected frequency
	1	2	3	4	5		
Left arch:							
Clinostomus	115	113	117	96	100	3.33	108.2
Semotilus	95	88	101	81	64	9.54	85.8
Right arch:							
Clinostomus	119	106	103	91	...	3.78	104.75
Semotilus	96	95	101	69	...	6.89	90.25

specimens of *Semotilus* ranged from 45 to 120 mm. in standard length and were captured in the vicinity of Ithaca, New York, during the summer months.

It was found advisable to keep the fish alive for several hours after capture to permit all the food material to pass through the pharynx and obviate regurgitation. They were killed and fixed in ten percent formalin prior to being cleared in two percent potassium hydroxide, stained with alizarine red S, and stored in pure glycerine (Evans, 1948). For the purpose of examination, the pharyngeal arches were removed as a unit with their mucous membranes and examined in glycerine under a dissecting microscope.

Replacement caps on the alizarine stained preparations appear as deeply stained tooth-germs beneath the pharyngeal mucosa, above and behind the bases of the functional teeth. As the tooth germ increases in size and the non-staining enamel covering is being deposited, one may note the resorbing basal attachment of the functional tooth which it is destined to replace (tooth 2 on left arch of Fig. 2). The ultimate fixation of the new tooth is effected by the development of ligamentous fibers between its base and the pharyngeal arch at the site of at-

TABLE II

FREQUENCY OCCURRENCE OF ALL POSSIBLE TOOTH-CAP COMBINATIONS, CONSIDERING ALL SIZES OF CAPS ON 150 PHARYNGEAL ARCHES OF *Clinostomus elongatus*

Left arch above double line, right arch below

(1)	(2)	(3)	(4)	(5)	Chi-square test for random replacement	
0	1	1	0	0		
(1,2)	(1,3)	(1,4)	(1,5)	(2,3)	X^2	Exp.
0	5	0	0	2		
(2,4)	(2,5)	(3,4)	(3,5)	(4,5)		
1	3	3	0	0		
(1,2,3)	(1,2,4)	(1,2,5)	(1,3,4)	(1,3,5)	102.4	5.0
1	0	3	23	3		
(1,4,5)	(2,3,4)	(2,3,5)	(2,4,5)	(3,4,5)		
1	1	4	14	0		
(1,2,3,4)	(1,2,3,5)	(1,2,4,5)	(1,3,4,5)	(2,3,4,5)	45.3	11.8
12	31	10	1	5		
(1,2,3,4,5)					....	....
25						
(1)	(2)	(3)	(4)		....	....
2	7	1	0			
(1,2)	(1,3)	(1,4)	(2,3)	(2,4)	29.22	5.66
3	6	2	17	4		
(3,4)						
2						
(1,2,3)	(1,2,4)	(1,3,4)	(2,3,4)		29.33	20.75
23	29	31	0			
(1,2,3,4)					....	....
23						

tachment of the functional tooth. By the time the replacement tooth has acquired its definitive size, its predecessor is shed and the new tooth, although not ankylosed to the pharyngeal bone, is occupying its final position in the functional series (tooth 4 on right arch of Fig. 2). The replacement tooth at this time has an unstained enamel tip and crown but it is deeply stained at its base above the clear ligamentous attachment. As basal ankylosis proceeds the staining affinity of the tooth diminishes.

Discussion

For the purpose of analyzing tooth succession only the major row has been considered on specimens showing the typical pattern of 4 functional teeth on the right arch and 5 on the left. The minor row of two teeth does not supply the necessary data for determining the order of succession. There is usually only one replacement cap between the two functional teeth and this cap is destined to replace whichever tooth is shed first. The frequency of replacement in the minor row appears to be similar to that of the major row.

The functional teeth or sockets in each major row were numbered consecutively from anterior to posterior. A replacement tooth if present was assigned the same number as the tooth it would replace, and only those teeth not ankylosed to the pharyngeal arch were considered as replacements. The replacement caps on each arch were recorded in an order of decreasing size. However, in many instances it was difficult to determine with certainty if one cap was appreciably larger than another and in such cases they were recorded as being replaced at the same time. In cases of an obvious difference in size from all other replacements on the arch, the caps were considered as being replaced at different times. Figure 2 shows four replacements present on the left arch, of which 1 and 3 were recorded as being replaced at the same time as were 2 and 5. There is no visible

Table III

Frequency Occurrence of All Possible Tooth-Cap Combinations, Considering All Sizes of Caps on 127 Pharyngeal Arches of *Semotilus atromaculatus*

Left arch above double line, right arch below

	Chi-square test for random replacement	
(1) (2) (3) (4) (5) 0 0 0 0 0		
(1,2) (1,3) (1,4) (1,5) (2,3) (2,4) (2,5) (3,4) (3,5) (4,5) 0 5 0 0 0 20 0 0 1 0	X^2	Exp.
(1,2,3) (1,2,4) (1,2,5) (1,3,4) (1,3,5) (1,4,5) (2,3,4) (2,3,5) (2,4,5) (3,4,5) 1 6 0 6 20 0 3 1 0 0	....	....
(1,2,3,4) (1,2,3,5) (1,2,4,5) (1,3,4,5) (2,3,4,5) 23 17 0 6 7	32.19	10.6
(1,2,3,4,5) 11	....	....
(1) (2) (3) (4) (5) 0 0 0 0 0	....	....
(1,2) (1,3) (1,4) (2,3) (2,4) (3,4) 0 24 0 5 14 1	....	....
(1,2,3) (1,2,4) (1,3,4) (2,3,4) 30 10 7 10	23.63	14.25
(1,2,3,4) 25	....	....

replacement for tooth 4. On the right arch only caps 2 and 4 are present. These were recorded as being replaced at different times because of their obvious difference in size.

The frequency occurrence of individual replacements on an arch suggested that the teeth are replaced with equal frequency. To test this hypothesis, the Chi Square test was applied. At P = .05 the values observed (Table I) allow the reasonable assumption of this hypothesis.

The frequency of all possible tooth cap cmobinations, considering all sizes of replacements on an arch, is shown on Tables II–III. By establishing the hypothesis that replacement is random, it is possible to apply the Chi Square test to those combinations with sufficient data to determine if this hypothesis is a reasonable one. On these two tables it is seen that in each instance, the Chi Square value at P = .05 is highly significant. Thus we are not dealing with a random replacement.

If tooth replacement is not random then a pattern of succession must exist. It is seen that certain combinations of similar sized teeth are more often found on an arch than are other combinations (Tables IV–V). Considering the frequency of occurrence for all possible pair combinations, one can establish the relationship of one tooth to another in the replacement order.

On the left arch of *Semotilus* replacement 1 occurs most frequently with 3 and next most frequently with 5. This can be written in the order 5–3–1 or 1–3–5 to show the relationship of these three teeth to one another in time of replacement. Replacement 2 appears most frequently with 4 and next most frequently with 1. This can be written in the order 1–4–2 or 2–4–1 to show the relationship of these three

TABLE IV

FREQUENCY OCCURRENCE OF ALL POSSIBLE TOOTH-CAP COMBINATIONS, CONSIDERING CAPS OF THE SAME SIZE ON 150 PHARYNGEAL ARCHES OF *Clinostomus elongatus*

Left arch above double line, right arch below

No. of caps present	Frequency distribution										
1	(1)	(2)	(3)	(4)	(5)						
	11	36	26	62	44						
2	(1,2)	(1,3)	(1,4)	(1,5)	(2,3)	(2,4)	(2,5)	(3,4)	(3,5)	(4,5)	
	1	89	8	2	0	23	51	0	0	1	
3	(1,2,3)	(1,2,4)	(1,2,5)	(1,3,4)	(1,3,5)	(1,4,5)	(2,3,4)	(2,3,5)	(2,4,5)	(3,4,5)	
	0	2	0	0	2	0	0	0	0	0	
4	(1,2,3,4)	(1,2,3,5)	(1,2,4,5)	(1,3,4,5)	(2,3,4,5)						
	0	0	0	0	0						
5	(1,2,3,4,5)										
	0										
1	(1)	(2)	(3)	(4)							
	40	95	49	53							
2	(1,2)	(1,3)	(1,4)	(2,3)	(2,4)	(3,4)					
	0	51	28	2	9	1					
3	(1,2,3)	(1,2,4)	(1,3,4)	(2,3,4)							
	0	0	0	0							
4	(1,2,3,4)										
	0										

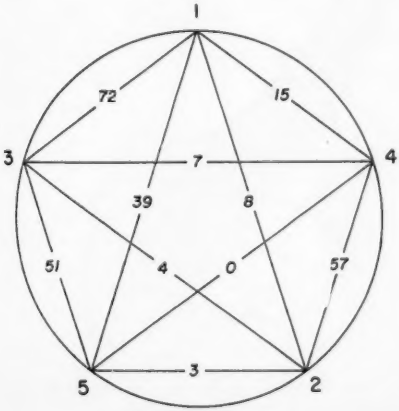
TABLE V

FREQUENCY OCCURRENCE OF ALL POSSIBLE TOOTH-CAP COMBINATIONS, CONSIDERING CAPS OF THE SAME SIZE ON 127 PHARYNGEAL ARCHES OF *Semotilus atromaculatus*

Left arch above double line, right arch below

No. of caps present	Frequency distribution
1	(1) (2) (3) (4) (5) 12 26 14 15 12
2	(1,2) (1,3) (1,4) (1,5) (2,3) (2,4) (2,5) (3,4) (3,5) (4,5) 0 26 2 0 0 50 0 0 10 0
3	(1,2,3) (1,2,4) (1,2,5) (1,3,4) (1,3,5) (1,4,5) (2,3,4) (2,3,5) (2,4,5) (3,4,5) 0 6 0 6 38 0 0 2 0 0
4	(1,2,3,4) (1,2,3,5) (1,2,4,5) (1,3,4,5) (2,3,4,5) 1 1 0 0 0
5	(1,2,3,4,5) 1
1	(1) (2) (3) (4) 18 45 25 21
2	(1,2) (1,3) (1,4) (2,3) (2,4) (3,4) 0 63 2 5 36 0
3	(1,2,3) (1,2,4) (1,3,4) (2,3,4) 4 5 4 0
4	(1,2,3,4) 0

teeth to one another. Combining these triads we have 5–3–1–4–2 or 2–4–1–3–5 with the following observed frequency relationships:



It is apparent in the preceding derivation of the tooth sequence based on the frequency occurrence of replacement teeth of the same size, that the direction of this succession has not as yet been determined. By correlating our raw data with this derived pattern, the direction of the normal order of tooth succession becomes quite clear. This was possible since the replacement caps were originally recorded in order of decreasing size. On Table VI it is seen that the order of tooth succession on the left arch of *Semotilus* in 61% of the specimens is 5–3–1–4–2, while in 2% the reverse order of 2–4–1–3–5 is found. In 31% of the fish either order is possible due to the fact that our data does not distinguish the slight differences in size between teeth which appear similar. The 6% of specimens which show no correlation can possibly be attributed to the inherent variability in the growth rate of replacement caps or to the oc-

TABLE VI

EVIDENCE FOR THE ORDER OF TOOTH SUCCESSION

Arch Genus	Order 14253	Order 35241	Either order possible	No correlation
Left arch:				
Clinostomus	102	12	9	27
	68%	8%	6%	18%
Semotilus	78	3	39	7
	61%	2%	31%	6%
Right arch:				
Clinostomus	117	2	22	9
	78%	1%	15%	6%
Semotilus	80	3	43	1
	63%	2%	34%	1%

casional interference of a replacement pattern by the premature loss of a tooth while feeding. The variations in the order of tooth succession on the right arch of *Semotilus* are similar to those on the left. Comparing *Semotilus* with *Clinostomus* as to variations in the order of succession (Table VI), we see obvious differences but their significance is not clear at present.

The most frequent order of tooth succession

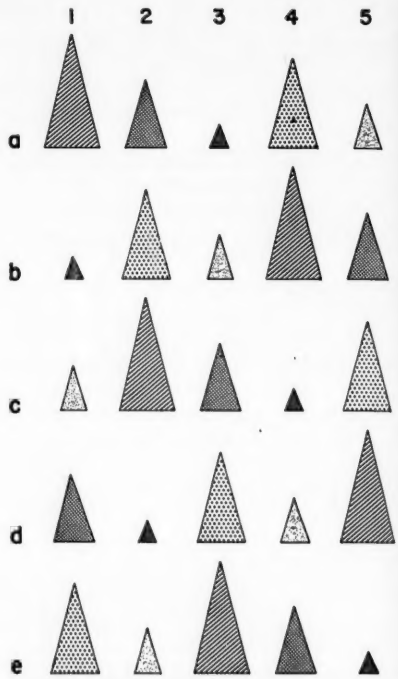


Fig. 4. Hypothetical stages in a typical replacement cycle starting with the pattern 1–4–2–5–3.

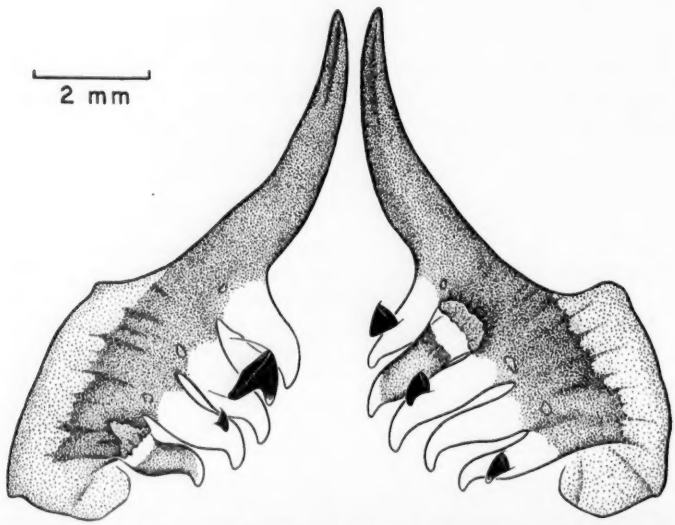


Fig. 3. Ventral view of the pharyngeal arches of *Semotilus atromaculatus* showing the functional teeth and replacement teeth of the major row. (Left arch appears on right hand side of figure).

(5–3–1–4–2) is well illustrated on Figures 2 and 3. We note in both species that replacement tooth number 2 on the left arch is the largest followed by 5, 3 and 1. The fourth replacement has not as yet appeared. On the right arch of *Clinostomus* (Fig. 2) the entire replacement order cannot be fully verified since only the 4th and 2nd replacements are present. However, on the right arch of *Semotilus* (Fig. 3) the order of succession is clearly 4–2–3–1. This order of replacement substantiates the findings of Belogorov (1940), who noted in larval carp that the functional teeth first appear in the order 3–1–2.

The five possible stages of a typical replacement cycle are illustrated diagrammatically in Figure 4. Beginning with an arch in replacement stage "a," the largest replacement tooth in each case will be the first tooth to ankylose as a functional tooth, followed by progressively smaller and younger replacements.

Although the actual time interval between successive replacements can only be ascertained by using live material, it is possible with the data available to determine the relative time interval. The frequency of occurrence of tooth cap combinations in Tables IV–V gives some indication of the time interval which exists between successive teeth. However, a better

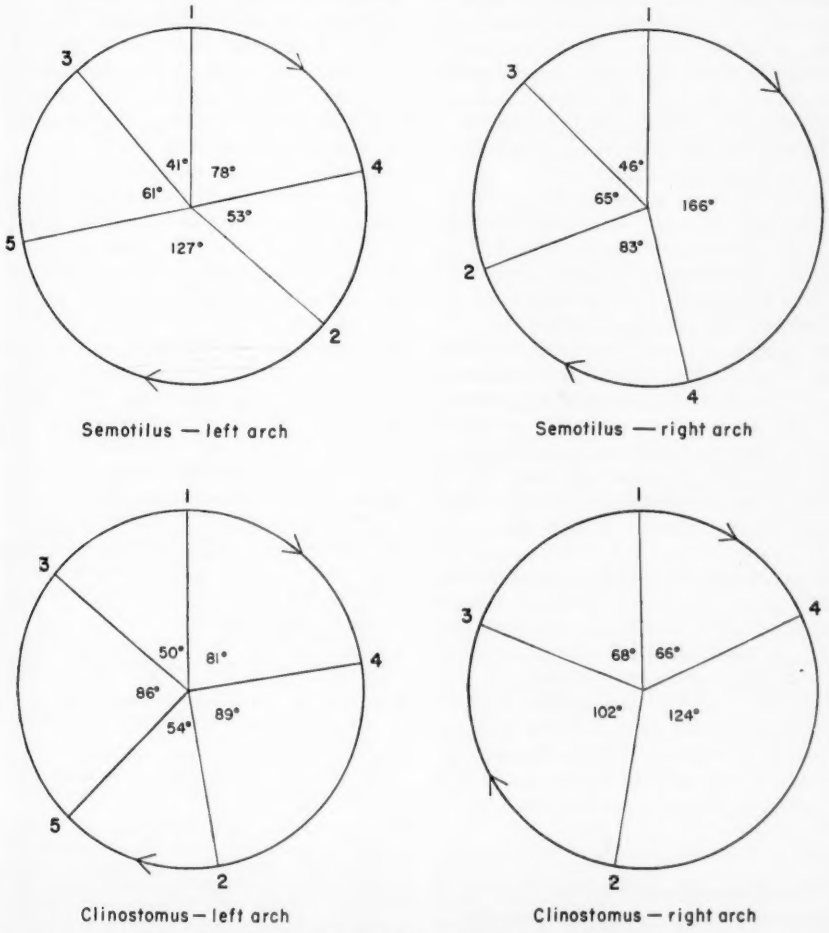


Fig. 5. The relative time interval between successive replacement teeth.

estimate of the time interval can be made by utilizing the total cap data of Tables II–III. This is true because regardless of the size of a replacement tooth, its appearance on an arch with other teeth serves as an indication of its proximity in time of replacement to these other teeth. Since tooth replacement is continuous throughout life, the order and relative time interval between successive teeth can best be illustrated as a cycle (Fig. 5). The frequency data extracted from Tables II–III have been converted to degrees in an inverse relationship, so that those teeth most frequently recorded as being replaced together are shown closest together in the cycle. The replacement teeth on the left arch of *Clinostomus* are rather evenly spaced in relative time compared to those of *Semotilus*. On the right arch of both species, the absence of the 5th tooth results in a considerable shift in the time of replacement of the 2nd and 4th teeth. We have no explanation for these differences at present.

From an examination of the replacement cycles (Fig. 5) which were derived from the total cap data, one can predict from the proximity of successive replacements, which teeth would be expected to be replaced at about the same time and thus appear similar in size. To illustrate, let us consider the left arch of *Semotilus*. Figure 3 shows teeth 1 and 3 closest together in time of replacement. However on Table V, we note that teeth 1 and 3 are not the most frequent pair combination. This is because the 5th tooth, which precedes 3 and 1, is so close in time of replacement that it is most frequently recorded as being replaced with teeth 3 and 1. Thus 5, 3 and 1 are more closely associated in time of replacement than are any other teeth. The 2nd and 4th teeth are closely related in time as seen on both the cycle (Fig. 5) and Table V. The greatest time interval is seen between the 2nd and 5th teeth. We would expect this combination to be rather infrequent and as a matter of fact, it is seen on Table V that this pair combination never occurred although they did appear four times in combination with other teeth on the arch.

Summary

The pharyngeal arches of 150 specimens of *Clinostomus elongatus* and 127 of *Semotilus a. atromaculatus* were cleared and stained to study the replacement teeth.

Tooth replacement is continuous throughout life and teeth are shed before the enamel crown is noticeably worn.

The presence, in two specimens of *Semotilus*, of three rows of teeth, some of which had worn crowns, is illustrated and considered to be the result of a disturbance in the normal process of replacement.

It is reasonable to assume that all teeth are replaced with equal frequency.

It is shown for the first time in teleosts, that the replacement of teeth is not random but rather in a definite order of succession. This sequence of replacement is usually 5–3–1–4–2 on the left arch and 3–1–4–2 on the right arch.

Although the actual time interval between successive teeth has not been determined, relative time intervals have been established and are illustrated for each arch.

Acknowledgments.—The writers would like to thank Miss Marion Newson who so ably prepared the illustrations; Dr. Douglas S. Robson for his statistical advice; Dr. C. Richard Robins, William S. Woolcott, and William S. Davis for their aid in the field and laboratory; and Dr. Edward C. Raney for his advice and reading of the manuscript. The field work of the junior author was supported in part by a grant from the New York State Science Service which he gratefully acknowledges.

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Fishes of the Little Missouri River

ROBERT GILES PERSONIUS AND SAMUEL EDDY

NEW aquatic habitats to be created by the big dams being built across the Missouri River will probably alter the distribution of the indigenous fish fauna. The Little Missouri River, one of the larger tributaries to be affected by inundation, enters the Missouri River in central North Dakota above Garrison Dam. Now nearing completion, this dam will form a large reservoir that at maximum size will flood about 40 miles of the Little Missouri River. In order to determine the species and distribution of fish before the river is altered, the senior author and his wife spent the months of June and July, 1950, collecting fishes from this river, in Wyoming and North Dakota.

The Little Missouri River is a steep-gradient stream (average fall 4.6 feet per mile) flowing through a heavily eroded non-glaciated valley of picturesque badlands. Ordinarily, the river has a wide shallow bed composed of constantly shifting sand and silt. During drouth years and seasonal low precipitation periods, the stream flow often ceases, leaving a series of pools. The water is clear during periods of low water, as the silt settles when the flow diminishes. Melting snow in the spring and thunderstorms in the summer send large floods of silt-laden water rushing into the stream. The average concentration of suspended silt is very high, approximately two and one-half times that of the Missouri River at Kansas City.

The river was seined at 17 locations from the headwaters in northeastern Wyoming to the junction with the Missouri in central North Dakota, 560 miles below the source. A knotted cotton seine, 20 feet long and 4 feet deep, with ¼-inch mesh, was used in all available habitats. Much of the stream had a firm, shallow bottom and was easy to seine, but there were a few deep pools and rocky stretches where seining was impossible.

Although early fish surveys had been made in this region (Evermann and Cox, 1896), no specific reference to the Little Missouri River appeared until Hankinson (1929) made his study of the fishes of North Dakota and referred to collections made from this river by Hubbs and Schultz in 1926. Simon (1946), in his studies of the fishes of Wyoming, made some collections from the headwaters of the Little Missouri.

Eighteen species of fishes were taken during this survey or were reported by other observers. Except for carp, these probably represent the original fauna. Four additional species found in tributaries were apparently introduced. The fishes collected are deposited in the Department of Zoology at the University of Minnesota.

Scaphirhynchus species, river sturgeon, was reported by local observers to occur at least fifty miles above the mouth during high water in the spring. The species cannot be identified, since no specimens were collected during this survey or reported in previous surveys.

Hiodon alosoides (Rafinesque), the goldeye, was reported for the lower Little Missouri River by Hankinson (1929). It was not taken by us.

Carpiodes carpio carpio (Rafinesque), the northern river carpsucker, was found throughout the course of the stream from source to mouth.

Catostomus commersoni commersoni (Lacé-

pède), the common white sucker, was found from source to mouth, but more abundantly in the headwaters.

Cyprinus carpio Linnaeus, the carp, occurred abundantly in the headwaters behind beaver dams but was taken only rarely downstream.

Hybopsis gracilis communis (Girard), the plains flathead chub, was the most abundant and widespread species found. Although taken at every station, it increased in relative numbers in collections toward the mouth of the river.

Hybopsis plumbea (Agassiz), the northern chub, is here reported from the Little Missouri for the first time. Most abundant in the headwaters, it was found throughout the river and in Beaver Creek, a tributary stream, where it may have been introduced as a bait minnow.

Hybopsis meeki Jordan and Evermann, the sickelfin chub, was also found in the Little Missouri River for the first time during this survey. Two specimens were taken near the mouth. This species is probably not present above the mouth.

Hybopsis gelida (Girard), the sturgeon chub, was not found. According to Hankinson (1929), Hubbs and Schultz took four specimens at Marmarth, North Dakota, in 1926.

Rhinichthys cataractae (Valenciennes), the longnose dace, was taken throughout the course of the Little Missouri but more abundantly in the headwaters.

Notropis deliciosus missuriensis (Cope), the plains sand shiner, most abundant in the middle reaches of the river, was collected from source to mouth.

Hybognathus nuchalis nuchalis Agassiz, the western silvery minnow, was not identified in the collections, although Simon (1946) reported it as the most abundant minnow in the Little Missouri River in Wyoming. Hubbs and Schultz took it near Marmarth, North Dakota.

Hybognathus placita Girard, the plains minnow, was found at every station but more abundantly toward the mouth. In numbers collected, it was next to the flathead chub.

Pimephales promelas promelas Rafinesque, the northern fathead minnow, was third in abundance. Collected in all parts of the river except near the mouth, it was in greatest abundance in the headwaters.

Ictalurus punctatus (Rafinesque), the channel catfish, was present over the entire length of the stream below the extreme headwaters.

Ameiurus melas melas (Rafinesque), the northern black bullhead, was present from source to mouth.

Noturus flavus (Rafinesque), the stonecat, was reported by Simon (1946) as uncommon in the upper portion of the Little Missouri River in Wyoming, but was not taken in the present survey.

Stizostedion canadense (Smith), the sauger, was taken near the mouth. Wyoming residents reported large specimens caught by anglers behind beaver dams before the drouth period of the middle 30's. None were taken in the upper river in this survey.

Other species of fishes have been introduced into some of the tributaries of the Little Missouri River. The largemouth bass, *Micropterus salmoides* (Lacépède), pumpkinseed sunfish, *Lepomis gibbosus* (Linnaeus), and black crappie, *Pomoxis nigromaculatus* (LeSueur) have been released in Beaver Creek behind Odlund Dam north of Beach, North Dakota. Largemouth bass have been planted in Spring Creek Dam on Coyote Creek near Marmarth, North Dakota. Apparently none of these has succeeded in migrating to the Little Missouri River to establish populations. The northern creek chub, *Semotilus atromaculatus atromaculatus* Mitchill, was taken from Beaver Creek immediately below Odlund Dam. This population suggests a probable introduction through a fisherman's minnow pail.

The native fishes of the Little Missouri River are typical of the western tributaries of the Missouri River but differ somewhat from those of the eastern (glaciated) tributaries in North Dakota. Random collections from several tributaries on the east side of the Missouri River near Bismarck, North Dakota, indicated a different fish fauna in the eastside streams. The headwaters of the eastern streams were characterized by the apparent absence of silty-water species such as *Hybopsis gracilis* and *Hybognathus placita* and by the presence of *Semotilus atromaculatus*, *Chrosomus eos*, *Eucalia inconstans*, and *Pimephales promelas*. Only the latter species was common to both drainages. The heavy silt loads carried by the Missouri and Little Missouri rivers create environmental conditions unsuitable for many fishes. Hubbs

(1940) and Moore (1950) have pointed out that many species of fishes found commonly in silty streams have become adapted for the conditions produced by the silt. It is possible that silt-laden water prevents many eastern species from crossing the Missouri and penetrating the lower reaches of its western tributaries to favorable headwater habitats. The Missouri River dams, by creating large still-water pools with little current and reduced turbidity, may alter the intervening habitat sufficiently to allow a mingling of the fish faunas of the eastside and westside tributaries, especially in their headwaters. The unimpounded portion of the Little Missouri River may be silty enough to act as a barrier, or the large reservoir may contain niches through which some species will not pass.

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The Effect of Marine Bacteria on the Development and Hatching of Pelagic Fish Eggs, and the Control of Such Bacteria by Antibiotics[1]

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THE occurrence of bacteria in the sea is widespread. ZoBell (1946) has reported an average of 1,000 bacteria per ml. in surface waters near shore. Such concentrations of bacteria may influence fishes by the liberation of proteolytic enzymes, by formation of toxins, or by the invasion of muscle, alimentary tract, and fins. Few investigators in marine microbiology have attempted to determine the significance of bacteria in the life cycle of marine fishes. Most of the fragmentary accounts refer merely to microorganisms that have caused the death or lesions on fishes (Plehn, 1924; Wells and ZoBell, 1934; Nigrelli, 1940; Rucker, 1949; Hodgkiss and Shewan, 1950).

Studies involving the relationship between bacteria and the life cycles of fishes are usually difficult and have been heretofore relatively little attempted. The tendency of marine bacteria to stick to solid objects (ZoBell and Allen, 1933) complicates experimentation. In determining the effect of marine bacteria on living organisms, the primary difficulty is to minimize contaminations. This problem is acute in the study of marine fishes because most of the agents used to decrease the bacterial population are also harmful to the fishes (Wells and ZoBell, 1934).

Of the several antibiotics that were employed in a recent study (Tarr, Southcott, and Bissett, 1950), aureomycin and terramycin were most effective in reducing the bacterial content of fishes during storage. At a concentration of 50 parts per million (ppm) these antibiotics did not inhibit all the bacteria but did decrease the total number which usually accumulated during fish storage. Spencer (1952) used antibiotics to decrease the bacterial population in studies with marine algae with reasonable success. These results suggested that antibiotics might

[1] Contribution from the Scripps Institution of Oceanography, New Series, No. 732.

[2] Research conducted in part as a Fulbright Fellow in marine microbiology in Norway, 1952–53.

TABLE I

NUMBERS OF VIABLE BACTERIA PER ML. OF SEA WATER FROM OSLOFJORD, NORWAY, CONTAINING DIFFERENT CONCENTRATIONS OF ANTIBIOTICS, INCUBATED AT 18°C., AND TESTED AFTER 12, 24, AND 72 HOURS INCUBATION

Antibiotic	Conc., ppm	Number of viable bacteria		
		12 hours	24 hours	72 hours
Penicillin	25	4,500	16,000	45,000
	50	2,700	900	43,000
	100	1,700	6,000	75,000
Neomycin	25	370,000	320,000	200,000
	50	45,000	33,000	170,000
	100	6,000	18,000	270,000
Strepto-mycin	25	20,000	30,000	47,000
	50	10,000	62,000	110,000
	100	10,000	72,000	330,000
Chloro-mycetin	25	5,500	15,500	120,000
	50	2,700	16,000	2,000
	100	600	13,000	1,500
Control (no antibiotic)	...	2,200,000	1,500,000	600,000

TABLE II

PLATE COUNT ESTIMATES OF NUMBERS OF BACTERIA PER ML. OF ANTIBIOTIC-TREATED SEA WATER AFTER DIFFERENT PERIODS OF TIME

The sea water was collected near La Jolla, California

Antibiotics, 50 ppm	Number of viable bacteria per ml.		
	12 hours	24 hours	144 hours
None (control)	3,000	1,000,000	2,000,000
Aureomycin HCl	100,000	100,000	2,000,000
Terramycin HCl	40,000	100,000	60,000
Penicillin G	300	10,000	5,000
Streptomycin-dihydro	400	10,000	200
Fradicidin*	20,000	100,000	5,000,000
Neomycin*	1,000	200,000	1,000
Tyrothricin†	5,000	100,000	1,000,000
Chloromycetin	65	150	100,000
Thiolutin§	...	850	100,000
Bacitracin§	...	4,000	10,000
Polymyxin§	...	3,500	200,000
Rimocydin§	...	5,000	30,000
Penicillin and streptomycin	2	5	75
Fradicidin and neomycin	3,000	100,000	2,000
Aureomycin and terramycin	100,000	1,000,000	2,000,000
Terramycin and penicillin	10,000	100,000	5,000,000
Chloromycetin and neomycin	...	0	0
Chloromycetin, penicillin and streptomycin	...	0	0

* Obtained through the courtesy of Commercial Solvents Corp., Terre Haute, Indiana.
† Obtained through the courtesy of Sharp & Dohme, Glenolden, Pa.
§ Obtained through the courtesy of Chas. Pfizer and Co., New York, N. Y.

reduce the bacterial content in sea water cultures of fish eggs.

This paper is concerned with a comparison of the number of pelagic fish eggs which hatch in the presence and absence of marine bacteria. The experiments were conducted in two widely separated regions, namely southern California, U. S. A., and Oslofjord, Norway. Data are included relative to the possible use of combinations of antibiotics that reduce the bacterial content of sea water.

METHODS AND MATERIALS

Several antibiotics were tested, alone and in combinations, for their ability to reduce the bacterial population of sea water. The antibiotics (Tables I–III) were water soluble compounds purchased locally from medicinal stocks, excepting those marked and acknowledged as samples. Weighed amounts of the antibiotics, corresponding to final concentrations of 25, 50 and 100 ppm, were added to sterile 250-ml. flasks containing 100 ml. of sea water. The sea water was collected from the end of the 1,000-foot pier at the Scripps Institution of Oceanography and at Huk, Bygdøy Island in Oslofjord, Norway. Before the sea water was added to the flasks, and thereafter at frequent intervals during the incubation period, the numbers of viable bacteria per ml. were determined by standard dilution and plating methods. The data recorded from plating procedure are the averages from duplicate tests. In this procedure colony counts were made after 6 days incubation at 20°C. In all instances the original antibiotic solutions were diluted more than 1:100 during the plating procedure, which tended to reduce their residual effect during colony formation. The dilution water consisted of a sterile mixture of 75 percent (by volume) sea water and 25 percent

TABLE III

PLATE COUNT ESTIMATES OF NUMBERS OF BACTERIA PER ML. OF ANTIBIOTIC-TREATED SEA WATER AFTER DIFFERENT PERIODS OF TIME

The sea water was collected from Oslofjord, Norway

Antibiotics, 50 ppm	Number of viable bacteria per ml.		
	12 hours	24 hours	72 hours
None (control)..	5,000,000	2,000,000	800,000
Aureomycin....	55,000	320,000	1,100,000
Terramycin....	85,000	10,000	2,900,000
Penicillin.....	2,700	900	43,000
Streptomycin...	10,000	62,000	110,000
Fradicidin.....	23,000	2,000,000	3,300,000
Neomycin.....	45,000	33,000	170,000
Tyrothricin....	...	2,750,000	1,800,000
Chloromycetin..	2,700	16,000	2,000
Thiolutin.....	63,000	850,000	1,100,000
Bacitracin.....	33,000	3,000,000	1,300,000
Polymyxin.....	60,000	1,100,000	1,600,000
Rimocydin.....	620,000	2,250,000	1,800,000
Ilotycin.....	2,800	1,000	13,000
Penicillin and streptomycin.	25	6	325
Penicillin and chloromycetin	150	40	15
Aureomycin and chloromycetin	400	90	40
Penicillin, streptomycin and neomycin....	80	33	450
Penicillin, streptomycin and polymyxin...	700	70	270
Penicillin, neomycin and polymyxin...	250	175	200
Aureomycin and polymyxin...	3,250	2,000	50,000
Penicillin and polymyxin...	500	150	200
Terramycin and polymyxin...	6,000	8,000	50,000

distilled water. The samples were plated using nutrient sea water agar medium No. 2216 (ZoBell, 1946).

The pelagic eggs of the Pacific sardine (*Sardinops caerulea*), the Norwegian codfish (*Gadus callarias*), and a turbot (*Pleuronichthys* sp., probably *ritteri*[3]) were investigated. The very fragile sardine eggs, which average 1.8 mm. in diameter, were collected from the ocean near the Scripps Institution by a one-meert plankton net (0.18 mesh). The eggs of the turbot were smaller and more spherical. The fresh plankton samples in sea water were transported to the laboratory in two-quart jars. Fertile eggs were separated from the rest of the plankton; the time interval from the collection of the eggs to their separation was usually from one to three hours. Because of their rapid development, only the early stages or young eggs were selected for the experiments. Normally the sardine eggs are spawned at night from the hours of eight PM to midnight (Ahlstrom, 1948); when collected the following morning, they were at a sufficiently early stage for the experiments. Both types of eggs matured to the larval stages in from three to four days, depending on the water temperature.

The codfish eggs were obtained from ripe, mature adults which were caught in Oslofjord. The eggs were stripped into a flat pan filled with sea water and fertilized by the addition of fresh sperm. The eggs and sperm were mixed and allowed to stand for 10 minutes after which time they were washed with sea water and placed in a cylinder to separate the fertilized eggs which floated to the top. The codfish eggs were spherical, 1.5 mm. in diameter, and developed to larvae in approximately 16 days at 5°C.

The eggs (Table IV) were washed in sterile sea water and transferred to sterile glass containers where they were allowed to incubate either in antibiotic solution or in running sea water. For each experiment with fish eggs, sea water for both the antibiotic solution and running sea water was obtained from the same source, either collected directly from the ocean or from laboratory sea water systems. Thus any toxicity from the water source or pipe systems was equally active against the eggs cultivated, whether in the antibiotic solutions or in running sea water. The antibiotic solutions were recirculated or allowed to flow into the flask at a rate approximately the same as that of the running sea water. The glass containers were placed in a constant temperature water bath set to maintain the temperature of the water where the eggs were collected. Cod eggs were also hatched in cotton-stoppered flasks containing 100 ml. of sea water and various single antibiotics (Table V). Twenty eggs were tested in each flask. The sea water was not changed

[3] This flatfish was identified by Dr. Grace L. Orton, Scripps Institution of Oceanography.

TABLE IV

PERCENTAGE OF EGGS OF *Sardinops*, *Pleuronichthys* AND *Gadus* THAT HATCHED, AND NUMBER OF BACTERIA BY PLATE COUNTS, IN RUNNING SEA WATER AND IN SEA WATER TREATED WITH 50 PPM EACH OF PENICILLIN AND STREPTOMYCIN

Genus	Number of eggs tested	Running sea water		Sea water plus antibiotics	
		% hatched	Bact./ml.	% hatched	Bact./ml.
Sardinops...	50	0	12,000	80	0
Sardinops...	50	10	...*	86	...*
Sardinops...	50	8	1,000	100	40
Pleuronichthys...	50	13	5,000	80	0
Gadus.....	100	1	30,000	28	1,100
Gadus†.....	100	65	25,000	78	1,500

* Not determined.
† Plus polymyxin.

TABLE V

PERCENTAGE OF TWENTY EGGS OF *Gadus* FROM OSLOFJORD, NORWAY, THAT HATCHED IN SEA WATER TREATED WITH 50 PPM EACH OF VARIOUS ANTIBIOTICS AT 9°C.

Antibiotics	Percentage of eggs hatched
None (control).....	65
Penicillin and streptomycin.....	80
Penicillin and polymyxin.....	80
Streptomycin and chloromycetin.....	0
Aureomycin and polymyxin.....	95
Terramycin and polymyxin.....	0
Penicillin, streptomycin and neomycin.....	85
Penicillin, streptomycin and polymyxin.....	85

during the incubation and the eggs hatched without being disturbed. At intervals during their incubation the numbers of hatched eggs were recorded and the numbers of viable bacteria were determined.

Experiments were also performed on board a research vessel in an area of maximum sardine spawning. The area was off San Cristóbal Bay, Baja California, approximately 29 miles offshore and about 400 miles south of San Diego, California. The sardine eggs were collected from a depth of 10 meters. Fifty early-stage eggs, separated under a microscope, were placed in 50-ml. vials containing sterile sea water. The open vials were covered by cheesecloth having ½-mm. mesh and placed in two jars. One jar was provided with running sea water at a temperature of 16°C. from the area near collection. The other jar contained a mixture of 50 ppm each of penicillin and streptomycin which was changed every 12 hours. Both jars were maintained at approximate constant temperature in a bath of running sea water. At the end of three days the contents of the vials were preserved in formalin for later examination at the shore laboratory. Upon termination of the cruise, the sardine eggs in the vials were examined by phase microscopy and the numbers of hatched and unhatched eggs were counted. Microscopic examinations were made on wet preparations by Spencer phase contrast using a 97-×, dark-M objective.

RESULTS

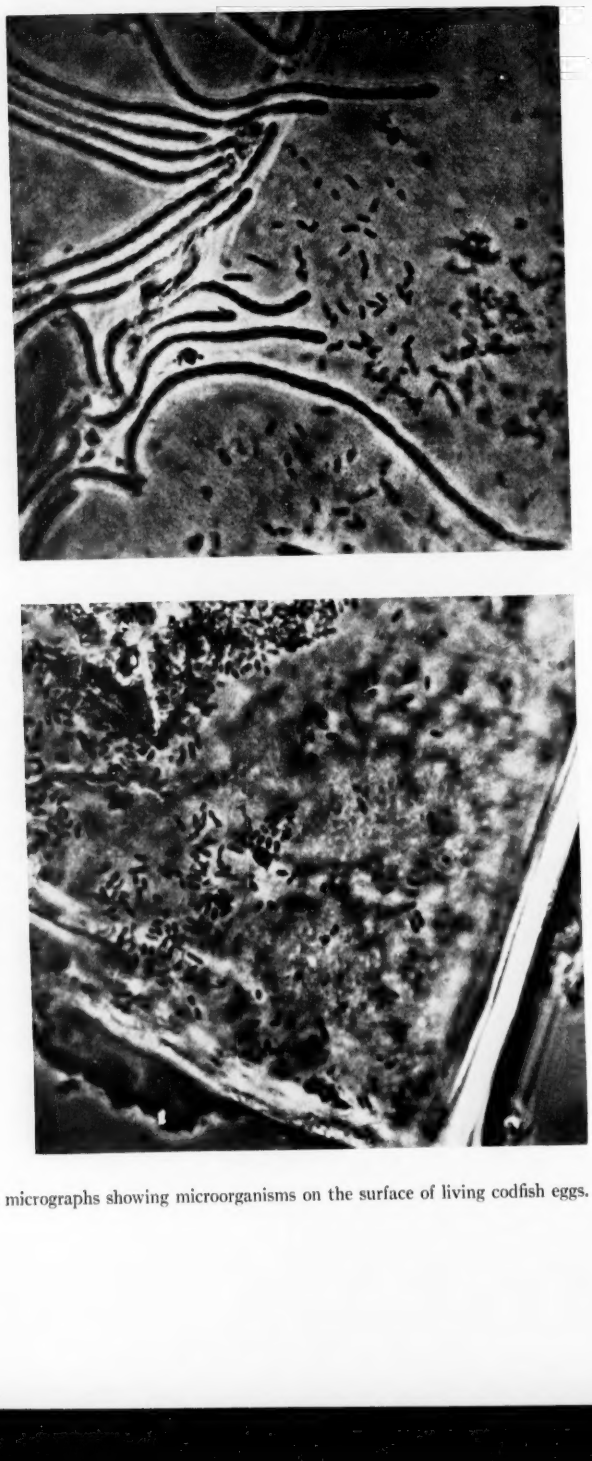
The most effective concentration of antibiotics proved to be 50 ppm, as indicated by a representative selection of several data (Table I). Above this concentration most of the antibiotics were somewhat toxic, and at lower concentrations the antibiotics showed decreased bacteriostatic activity. Therefore 50 ppm was used in subsequent experiments.

In the southern California region, combinations of penicillin-streptomycin and of chloromycetin-neomycin were the most effective in reducing the bacterial populations (Table II), but differed in toxicity for fish eggs. Marine fish eggs placed in a fresh solution of penicillin-streptomycin evidenced no ill effects, but the chloromycetin-neomycin mixture injured the eggs.

Toxicity tests for cod eggs indicate that 50 ppm of chloromycetin, aureomycin-neomycin, terramycin-polymyxin and tyrothricin were lethal after 12 hours of incubation.

In the area of Oslofjord, Norway, several combinations of antibiotics were more or less effective. In no instances were the bacteria completely eliminated by the use of antibiotics, and it was not unusual to have one or two species remaining (Table III).

Tables IV and V show several experiments which compare the hatching of the various eggs in sea water with and without antibiotics. As is shown, a higher rate of hatching occurred in the antibiotic-treated sea water except for the certain antibiotic mixtures which were



Phase micrographs showing microorganisms on the surface of living codfish eggs. × 2,000.

toxic. Many of the eggs in untreated sea water became opaque during the incubation, while those in antibiotic-treated sea water remained clear. Microscopic examinations (Plate I) revealed the abundance and types of bacteria that accumulated on the surface of the eggs during incubation in running sea water. The eggs of the cod, which needed a longer hatching time, were covered first with bacteria and then with various types of diatoms and dinoflagellates. These eggs usually became so heavy with attached organisms that they sank to the bottom of the flask. In most of these experiments the eggs in running sea water had many bacteria on their surfaces, while the eggs in antibiotic solution had relatively few bacteria.

Discussion

Marine conditions are somewhat different from those of terrestrial environments where antibiotics are commonly employed. For example, certain of the antibiotics such as terramycin and aureomycin may be less bacteriostatic in sea water, which contains approximately 3.4 percent salts. Furthermore, aureomycin, which is most active at a pH of 7.0, is not so effective in sea water at pH 8.2.

The normal bacterial flora of sea water is variably affected by different antibiotics. However the inhibitory properties of the antibiotics may depend on the source of water with respect to temperature, organic material, salinity etc. Certain antibiotics inhibited marine bacteria (Tables II and III). Some had no effect, while others appeared to stimulate bacterial reproduction (Table II; compare the control with aureomycin HCl). The stimulatory effect was not studied further, so it is problematical whether the antibiotics provided a growth-promoting substance or merely suppressed one or more groups of bacteria allowing better growing conditions for those remaining. Of all the antibiotics examined, penicillin, streptomycin and chloromycetin appeared to be the most effective in reducing bacterial populations. Mixtures of these compounds reduced the populations in water near La Jolla to a point where no microbial growth was detected in nutrient sea water medium.

The mixture of terramycin and penicillin gave interesting results. Although the compounds when used separately reduced the bacterial population, the mixture had less effect. These results suggest that the two antibiotics were antagonistic to each other in combinations. This counter effect has been noted by Speck, Jawetz and Gunnison (1951), who reported that aureomycin interfered with the action of penicillin both *in vitro* and *in vivo* when species of *Streptococcus* and *Klebsiella* were the test organisms.

At a concentration of 50 ppm, chloromycetin, neomycin, polymyxin and rimocydin killed small fish and dinoflagellates within 12 hours. The combination of penicillin and streptomycin had little or no toxicity over long-range experiments with fish eggs, larvae or adults. In the botanical laboratory at Scripps Institution, Beatrice M. Sweeney (in 1952; personal communication) determined that the combination of penicillin and streptomycin at 50 ppm each is nontoxic to *Gymnodinium splendens* and produces bacteria-free cultures of this dinoflagellate. Its reproduction, however, is prevented. After the organisms were replaced in an antibiotic-free medium, reproduction and growth were more rapid than normal. Hoffman (1949) successfully eliminated freshwater bacteria by the use of the combination of penicillin and streptomycin in the isolation of pure cultures of *Saprolegnia* and *Aschlya*.

It is possible that bacteria have much more influence on the eggs of marine organisms than has been realized. Although *in situ* conditions are very difficult to duplicate in the laboratory, the evidence on hand suggests that bacteria accumulate on the eggs until present in sufficient numbers to be injurious. It is not known whether the large numbers of bacteria on the egg surfaces is due to the attraction by surface charge or by reproduction of the bacteria originally present. Both factors probably operate. Dannevig (1919) noticed that cod eggs became overgrown with organisms resembling *Leptothrix* which resembled the larger chain-like forms in Plate I. The phase photomicrographs (Pl. I) of the surface of a cod egg illustrate how concentrated the bacteria may become when the eggs are incubated in running sea water. The large chain-like organisms are an unknown species. Eggs incubated in an antibiotic solution of penicillin-streptomycin had few or no bacteria on the surface. In an experiment conducted to correlate the numbers of bacteria in the

ocean with the presence of bacteria on the surface of the eggs collected in the same area, the surrounding water contained only a few bacteria per ml., and only an occasional egg had bacteria adsorbed on its surface.

Microscopic examinations showed that other organisms grew on the cod eggs. At times these populations became so great that the eggs lost their buoyancy and sank. According to Dannevig (1919), cod eggs cultivated in sunlight lost their buoyancy. Although Dannevig did not explain this effect, heavier diatoms or other organisms may have grown much faster in sunlight and therefore, by this additional weight, overcame the buoyancy of the eggs. This suggests that, if eggs were spawned in a fjord where dissolved oxygen was present only in the surface layers, the eggs thus losing their buoyancy might drop below the oxygen layer and subsequently die.

Marine bacteria may be responsible for a large proportion of abnormal eggs found in routine collections in areas of maximum sardine spawning on the California Coast. Ahlstrom (1948) has shown that as many as 45 percent of the eggs from net hauls may be abnormal. The abnormality was usually indicated by a cloudy appearance somewhat similar to denaturation. Similar eggs collected in 1953 had numerous bacteria on their surfaces. Large numbers of bacteria could cause the denaturation. ZoBell (1946) found 65 percent of the described marine bacteria to be proteolytic. Sette (1943) stated that the mortality of early stages of marine fishes is outstanding, as evidenced from a comparison between the numbers of eggs and larvae collected in plankton surveys. Rollefsen (1932) has reported that cod eggs are easily damaged by mechanical injury. The earlier-stage eggs were found to be the most susceptible.

It is reasonable to say that up to the present there has been found no comprehensive analysis of the term "natural mortality" in the population equations which have been prepared for natural stocks. The term has, in fact, been chiefly an item introduced by deduction into an arithmetic operation. Much attention has been paid to the measurement of the amount of mortality, but little work has been done on its cause, and that which has been done has been related chiefly to physical effects on the egg and larval stages. Thus Dannevig (1940) suggested that certain physical effects caused by high winds might be lethal to eggs; and Sette (1943) and others have written of the effects of currents in carrying eggs and larvae into situations unfavorable in respect to salinity, temperature or food supply.

The antibiotic solution did not increase the rate of egg development. The most significant point is that more than 75 percent of the eggs in antibiotic solution hatched. This discovery may prove significant in fish practice and it may also lead the way to the more successful rearing of the young stages of marine fishes.

Summary

A series of thirteen antibiotics were tested alone and in combination for their effect on bacterial populations in sea water from the coast of southern California and from Oslofjord, Norway. Most of the aerobic, heterotrophic bacteria from sea water near La Jolla, California, were inhibited. While the antibiotics did appreciably decrease the numbers of bacteria in sea water from Oslofjord, more bacteria were resistant. Penicillin, streptomycin and chloromycetin were the most effective in reducing the bacteria populations; however, chloromycetin proved to be toxic to the eggs studied.

The pelagic eggs of the Pacific sardine (*Sardinops caerulea*), of the Norwegian codfish (*Gadus callarias*) and of a Pacific turbot (*Pleuronichthys* sp., probably *ritteri*) were investigated. The eggs were obtained by collection from the sea in plankton nets or by the removal and fertilization of mature eggs. The early-stage eggs were incubated in running sea water and in circulating sea water containing antibiotics. A mixture of penicillin and streptomycin did not appreciably increase or decrease the rate of development, but did increase the percentage of eggs hatching. This percentage in the antibiotic solution was three times greater than that in running sea water. Microscopic examinations demonstrated that the eggs in running sea water had many bacteria on their surfaces, while those in antibiotic solution had very few bacteria. Numerous bacteria were also demonstrated on the surfaces of later-stage eggs collected from the sea. During the long incubation time required by the cod eggs at 5°C., it was noted that an abundance of algae, bacteria

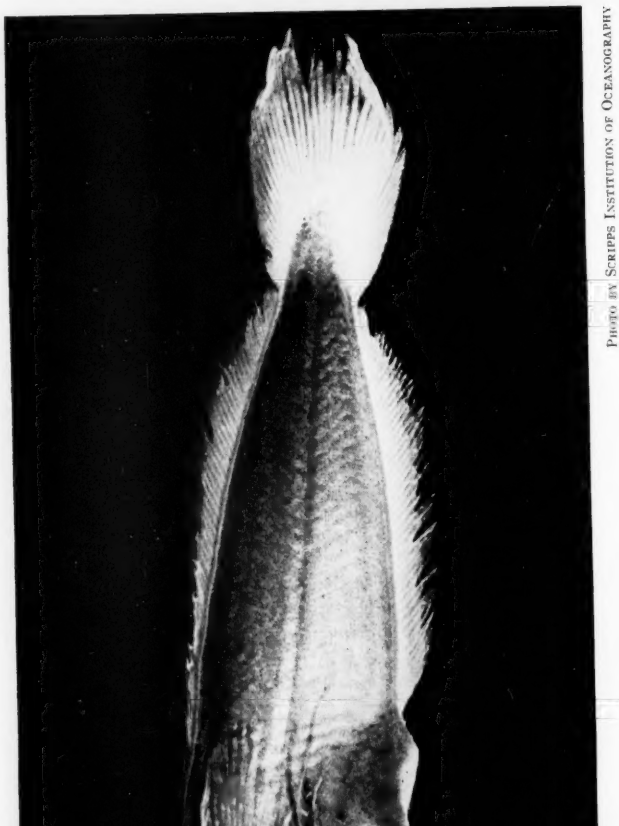


PHOTO BY SCRIPPS INSTITUTION OF OCEANOGRAPHY

"Gaidropsarus vulgaris (Yarrell)"—a juvenile from Laborador Sea. Standard length 23 mm.

and diatoms were present on the egg shells. At this time the eggs lost their buoyancy and fell to the bottom of the incubation chamber.

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A Juvenile Gadid Fish from the Ladrador Sea Representing a Species of *Gaidropsarus* Apparently New for North America[1]

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RECOGNIZING the impossibility of the occurrence in the Labrador Sea of any such tropical blenny, I requested the loan for study of the specimen reported as "*?Entomacrodus* sp." from Station "B" in the Labrador Sea, at Lat. 56° 30′ N., Long. 51° 00′ W. (Kielhorn, 1952: 246–7). The identification was speculative, for the recorder stated: "Except for its larger size, this fish resembles in many particulars one of the species of *Entomacrodus* as figured by Garman (1899, Plate L, Figure 1). Inasmuch as this is not a planktonic form, further taxonomic evaluation is being withheld until a later date." Charles J. and Marie Poland Fish, of the Department of Zoology, University of Rhode Island, promptly acceded to the request. An examination of the specimen showed at once that any resemblance to a blenniid is superficial.

The specimen (Pl. I), 23 mm. in standard length, obviously represents the juvenile stage of a species of the gadid genus *Gaidropsarus* (commonly called *Onos*), which is best developed in north-boreal waters (Svetovidov, 1948: 77–88), but has an antitropical distribution (Hubbs, 1952). It has a rudimentary barbel on the flap of each anterior nostril and one at the tip of the chin, but none at the front of the snout. The dorsal fin comprises an isolated ray (very short in this juvenile) at the nape, well separated except for a slight dermal fold from the otherwise undivided dorsal, which, like the undivided anal, is separated very narrowly from the rudimentary rays of the isocercal caudal.

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 733.

The slightly oblique base of the rounded pectoral fin lies in the upper half of the shoulder region. The pelvic fin, which has 3 upper rays isolated and produced, and has a strongly oblique base, arises immediately behind the shoulder girdle, well above the ventral edge of the breast and distinctly in advance of the pectoral base. The streamlined contours, compressed body, smoothly rounded head, and the strong silvery tone retained in formalin, even underlying the dark areas, stamp this fish as a pelagic juvenile of the type that has been developed independently by many unrelated fishes (Hubbs, 1941: 184–5). It has long been known that the gadids of this genus and of immediately related genera pass through such a pelagic stage, during which they are known in Britain as "mackerel midges."

The head and body are heavily charged with dark pigment and become almost sooty black in a diffuse band from the eye to the posterior part of the base of the main dorsal fin. The sides are also considerably darkened, deeply so toward a rather abruptly lighter area on the triangular caudal base. The belly is bright silvery, with fewer, weaker, and more scattered melanophores. The lower parts of the head are also light, except close to the eye and toward the outer edge of each mandible. The fins are whitish, except for dark linings on the produced pelvic rays. In life, no doubt, the upper parts are metallic blue; the lower parts, especially forward, bright silvery.

The ray formula (D approximately 65, A 51, P_1 24—24, P_2 8—8) fits only one species as currently recognized. This is the north-European species called *Onos vulgaris* (Yarrell) by Collett (1892: 12–3) and *Gaidropsarus vulgaris* (Yarrell) by Svetovidov (1948: 86–7), but referred by Collett (1903: 65–6) in a second paper to *G. argenteolus* (Montagu). The name *argenteolus* is now recognized as a synonym of *G. mediterraneus* (Linnaeus), and the name *vulgaris* appears to have been based on the same species (an opinion concurred in by N. B. Marshall of the British Museum). The north-European species with high ray counts has apparently never been validly named. I trust that some European ichthyologist with access to good material will soon supply a name. In the interim the name "*Gaidropsarus vulgaris* (Yarrell)" may be employed.

Two other species, the two that have been validly reported from Greenland (Jensen, 1948: 168–73), namely *G. ensis* (Reinhardt) and *G. argentatus* (Reinhardt), the latter commonly named *G. reinhardti* (Collett), also have 8 pelvic rays and more than 20 pectoral rays, but neither has more than 60 rays in the principal dorsal fin or as many as 50 in the anal. Jensen indicated that the pelagic young of *Gaidropsarus* appear commonly along the coast of Greenland, but he identified those he had as *G. argentatus*.

According to William V. Kielhorn (*in litt.*) the identification of this specimen with a European species "does not disagree with other data from the collection, namely, isolated specimens of *Sagitta setosa*, *Halocypris globosa*?, and *Physophora hydrostatica*, which appeared presumably from the eastward." Templeman and Fleming (1954) have just reported the European ling, *Molva molva* (Linnaeus), from Newfoundland. These recent discoveries of European species in America may be related to the Arctic amelioration of climate.

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Ichthyological Notes

POST-SPAWNING BEHAVIOR OF THE KOKANEE, *ONCORHYNCHUS NERKA KENNERLYI*, IN DONNER LAKE, CALIFORNIA.—Schultz and students (1935, Jour. Pan. Pac. Res. Inst., 10: 67–77) made a rather complete study of the breeding activities of *Oncorhynchus nerka kennerlyi* (Suckley) in Swamp Creek, a small tributary to Lake Washington, Washington. Curtis and Fraser (1948, Calif. Fish and Game, 34: 111–4) and Kimsey (1951, *ibid.*, 37: 273–9) furnished additional data on the spawning of kokanee in Donner Lake, California. Observations on post-spawning behavior of this landlocked form of the red salmon, made by the author in December, 1949, at Donner Lake, seem worth recording.

On November 15, 1949, the first male kokanee had appeared on the spawning beds and much dashing about and fighting occurred among them. Females were not seen, although gill netting revealed them to be present in the deeper water at the edge of the spawning gravels, in two to six feet of water. Observations on subsequent spawning behavior were sparse and difficult to make, but did not appear to deviate from those previously reported.

On December 12, 1949, four nests were observed in an area about 30 feet long by 20 feet wide (Fig. 1), with five females and five males in attendance. Four of the females had well defined nesting areas, while the fifth appeared to be cruising aimlessly throughout the area. Each nesting location had at least one male. The following behavior was observed during a three-hour period in the afternoon.

The behavior of the males was uniformly lethargic. They either cruised aimlessly about or hovered in the positions indicated in Figure 1. Only once did one join a female over a redd. A few unassociated males cruised along the shore in groups of two or three. In contrast with behavior at the beginning and during the height of the spawning, no fighting occurred between males. They were covered with sores and the anal and dorsal fins were almost completely worn away. None had caudal fins; the bones in the hypural plate were frequently exposed; and in some instances the neural spines protruded.

The females, in contrast, were very active and remained near the centers of their nesting territories except when cruising and circling the borders, or when chasing female intruders. They paid no attention to the males, neither those that appeared to be associated with their nesting area nor the ones cruising along the beach.

In Figure 1, each female is shown on the apparent location of the redd and each is given a letter for identification purposes. Female A was in poor condition, with the caudal fin gone, anal fin shredded, and large sores on her back. Each time she came to the side of the big rock during her cruise of the territorial perimeter, she paused, pressed her anal fin and tail into the nest cavity, and attempted to excavate by flexing her body from side to side. She sometimes turned on her side and weakly flexed in the manner of fish building a nest in a current. She then continued circling the perimeter of her territory. A male joined her once during the activities over the spawning area, but it was clear that no eggs or milt were extruded. This female was not aggressive. Except for a brief bout with female B, her clashes were with the small female who maintained no territory and was cruising aimlessly through all four territories.

Female B was only slightly injured, having only the anal fin and lower half of the caudal fin shredded. This female was the most pugnacious and always attacked any transgressor on her territory. She repeatedly chased the stray female and often bit

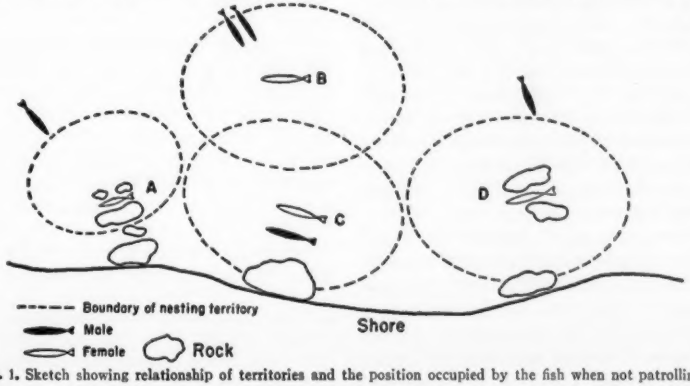


Fig. 1. Sketch showing relationship of territories and the position occupied by the fish when not patrolling

her. She had one brief bout with female A, several with D, and frequent ones with C. This female was not observed to participate in any action associated with egg laying. The center of her territory was clean and appeared to be a redd, although the surface material was fine, the largest being of pea size.

Female C was in poor condition, with scarred back, frayed dorsal fin, and the caudal and anal fins nearly gone. This female was aggressive only when others entered her territory. She chased out the wandering female and occasionally female D, often much farther than the territorial boundary. The clashes with female B were so frequent that it appeared their territories overlapped. No actions associated with egg deposition were noted, although the center of the territory appeared to be a redd.

Female D was in fair condition, with only a frayed anal fin. It appeared that the small stray female was trying to establish herself in this area, and repeated clashes occurred between these two.

Generally the behavior noted in Donner Lake did not differ greatly from that observed by Schultz (*op. cit.*). There is an indication, however, that the nest building actions have been modified for lake conditions, where no current is available to aid in excavating the nest and covering the eggs. The side-to-side motions of the anal and caudal region noted in female A was designed to lift material out of the redd and fan it to one side or to push material back into the excavated nest to cover the eggs, and was comparable to the movements of the eastern brook trout as reported by Greeley (1932, Trans. Amer. Fish. Soc., 62: 239–48) and Smith (1941, Jour. Wildlife Mgt., 5: 461–71). The more characteristic flexing on the side, so commonly noted in *Oncorhynchus*, probably serves the purpose of loosening the material during excavation.

Kokanee observed in Donner Creek, the outlet of Donner Lake, did not differ in their behavior from those observed by Schultz in Swamp Creek.

The instinct for defending the territory appears to persist in the female until death. All fish were dead when the area was visited on December 23, 1949. In contrast, the initial ferocity of the male in driving away intruders and protecting the nesting territory does not persist, even though no current is present to sweep them downstream and away from the area when they no longer have the strength to maintain themselves against it. From the beginning of the spawning period the female tolerates all males, often accepting the attention of males other than the one paired with her while he is chasing off other male intruders. Her nesting territory is threatened only by other females and, although no fighting over territory was noted during the early stages between females, the female certainly appears to recognize this threat later on in the period and defends her territory viciously against all other females. Very definite boundaries to her territory are obvious, and she seldom pursues an intruder any great distance beyond them.

Smith (*op. cit.*) regarded this persistent defense of the nest by the female brook trout as a rudimentary nest-guarding habit useful in preventing other females from tearing up earlier nests during their spawning activities. In the extremely crowded situations in certain salmon spawning streams, this rudimentary habit may well be a primary one that insures production. It was certainly useful in Donner Lake, where during the later part of the lake drawdown regime the spawning fish were restricted to a narrow spawning shelf that could accommodate only a fraction of those present.—J. B. KIMSEY, *Inland Fisheries Branch, California Department of Fish and Game, P.O. Box 542, Carmichael, California.*

ABNORMAL BIRTH OF BROODS IN THE VIVIPAROUS POECILIIDS *LEBISTES RETICULATUS* AND *XIPHOPHORUS HELLERI*.—Reproductive behavior of some of the poeciliids has been extensively studied and general facts concerning reproduction in these viviparous fishes are well known. (See review by Rosenthal, 1952, Biol. Bull., 102: 30–8). In the course of a series of studies on the nature of the mutation resulting in spinal curvature in the guppy, *Lebistes reticulatus* (Peters) and other fishes (Rosenthal and Rosenthal, 1950, Jour. Hered., 41: 217–8; Rosenthal, 1951, *ibid.*, 42: 257–9), six guppies and four *Xiphophorus* hybrids were observed to give birth to non-viable ova and/or embryos with mature living fry at termination of a normal brood interval. To the author's knowledge, this phenomenon has not previously been reported, although similar observations have been made in species of *Platypoecilus*[1] by Dr. C. L. Turner (personal communication).

The recorded data (Table I) were obtained when the actual birth process was observed or shortly thereafter. In all cases, the parent fish immediately searched for and devoured any of the ova and/or embryos that were released. However, in heavily planted aquaria many of the ova could be recovered before they were eaten. Since the birth process has only been observed about 25 times during the past five years, the ten observations of abnormal births represent approximately 40 percent of the observed births. Although the recorded number of observa-

[1] Gordon (1951, Aquarium, 20: 277–9) has recently suggested that since *Xiphophorus* and *Platypoecilus* are best regarded as congeneric, and since *Xiphophorus* has priority, both groups should be referred to that genus. However, in order to avoid undue confusion and to follow the pre-existing literature, *Platypoecilus* and *Xiphophorus* in this report refer to platyfish and swordtail strains, respectively.

TABLE I

ABNORMAL BROOD PRODUCTION IN *Lebistes* AND *Xiphophorus*

Stage of development in parentheses

Species	Number of mature embryos in brood	Number of ova and immature embryos in brood
L. reticulatus:		
1	6	1 ovum
2	11	4 ova
3	3	4 embryos (10)
4	11	4 ova
5	15	3 ova, 2 embryos (10)
6	9	3 ova
X. helleri:		
1	20	9 ova
2	7	5 ova
3	8	2 ova
4	38	8 ova, 3 embryos (10), 8 embryos (22)

tions is relatively small, it is believed that the phenomenon occurs to a similar extent in all broods produced by these fishes.

When the ova were released they were 1.5 to 2.0 mm. in diameter, transparent and pale yellow. A few small globules of fat were present around the germinal vesicle. The globules in this position indicate degeneration of the ovum, since yolk fat in viable ova is colloidally dispersed. Fertilization had occurred in some of the ova, as shown by a well defined blastopore and diffuse blastodisc. The embryos which were examined approximated stages 10 and 22 of embryonic development, which compares with morphological ages of about 4 and 15 days, respectively (Tavolga and Rugh, 1947, Zoologica, 32: 1–15).

Abnormal embryos, runts and degenerating ova have been observed in the ovary with normally developing young in various poeciliid fishes that do not normally demonstrate superfetation, such as *Lebistes* and *Xiphophorus*. In this connection Scrimshaw (1944, COPEIA (3): 180–3) has stated, in "most of the fish for which superfetation is listed as a rare occurrence . . . abnormal embryos or runts may be difficult at times to distinguish from embryos fertilized later than those of the main brood. These do not represent superfetation but merely something genetically or environmentally wrong with the individual fish." Tavolga (1949, Bull. Amer. Mus. Nat. Hist., 94: 161–230) has observed similar abnormal embryos in the ovary of *Platypoecilus*, *Xiphophorus* and their hybrids. The most common abnormalities were over-ripe ova, unfertilized ova and degenerate blastula or gastrula. Abnormalities in later stages of embryonic development were exceedingly rare. However, in one strain of platyfish, he found dead and degenerating embryos at later stages of development. The ultimate fate of these abnormalities has not been explained and in none of these reports is reference made to the release of non-viable ova or embryos with the birth of a viable brood.

Degeneration and resorption of ova in unfertilized female poeciliids has been demonstrated in *Heterandria* (Fraser and Renton, 1940, Quart. Jour. Micr. Sci., 81: 479–516), *Lebistes* (Liu, 1937, Ph.D. Thesis. Univ. College, London, Eng.), *Gambusia* (Thirumallacher, cited by Fraser and Renton, 1940), and *Platypoecilus* (Tavolga, *op. cit.*). This phenomenon was interpreted by Rosenthal (1952) to indicate an ill-defined estrus cycle in which ova mature, and in the absence of fertilization, degenerate and are resorbed. This interpretation was supported by the observation that virgin *Lebistes*, after insemination, produced broods over a wide interval of time (23- to 45-day brood intervals). Jaski (1939, Proc. Kon. Med. Akad. Weten., 42: 201–7) has indicated that an estrus cycle occurs in *Lebistes* every 3 or 4 days, although this report has not been substantiated (Clark and Aronson, 1951, Zoologica, 35: 49–66).

Since unfertilized ova in virgin female poeciliids are resorbed, one must assume that non-viable ova or embryos in fertilized fishes are also resorbed (Fraser and Renton, 1940), and it is doubtful if unfertilized ova or embryos in blastula or early gastrula stages could remain in the ovary for the entire gestation period of 23 days without being resorbed. On the other hand, embryos that died sometime towards the end of gestation would not be completely resorbed and would be released with the main brood.

In view of these data, the release of non-viable ova, blastula and early gastrula stages with the main brood may be explained by assuming that the abnormal ova matured and were fertilized at a later date than the ova of the main brood. The observations reported here may indicate a tendency for *Lebistes* and *Xiphophorus* to exhibit non-functional superfetation.—HAROLD L. ROSENTHAL, *The Rochester General Hospital, Rochester 8, New York.*

INQUILINISM AND A NEW RECORD FOR *PARAMIA BIPUNCTATA*, A CARDINAL FISH FROM THE RED SEA.—During a recent visit of Dr. Leonard P. Schultz to the Hayvanat Enstitüsü, Istanbul, Turkey, Dr. Curt Kosswig, Director, mentioned that he had observed a striped cardinal fish in the Red Sea living among the spines of a sea urchin. This habit has never been recorded for any striped apogonid. Through the generous cooperation of Dr. Kosswig, one of these specimens, USNM 163459, 39 mm. in standard length, taken

by him at Al Ghardaqa, Red Sea, was received and is identified as *Paramia bipunctata* Lachner (1951, Proc. U. S. Nat. Mus., 101: 604).

Paramia bipunctata was heretofore known only by the three types collected at Tarut Bay, Persian Gulf. It may be easily misidentified in the field because of its similarities to *Cheilodipterops isostigma* Schultz and to *Paramia quinquelineata* (Cuvier and Valenciennes). These species show a remarkable parallelism in the development of black horizontal body stripes as well as in size, proportions and general coloration. The trenchant characters readily distinguishing *bipunctata* are the black spot on the dorsal side of the caudal peduncle and the enlarged black spot at the base of the caudal fin (Lachner, 1953, U. S. Nat. Mus. Bull. 202, 1: 479, 481, 488–9, pl. 42, A, B, C). Although Rüppell probably reported *P. quinquelineata* from the Red Sea as early as 1835 (*Apogon novemstriatus*, Neue Wirbelthiere . . . fauna Abyssinien – Fische des Rothen Meeres: 85, pl. 22, fig. 1) and although it has been subsequently listed by several authors (Klunzinger, 1870, Synopsis der Fische des Rothen Meeres: 716; 1871, Systematische Uebersicht . . .: 1,354; 1884, Fische des Rothen Meeres: 23; Ben-Tuvia and Stenitz, 1952, State of Israel, Dept. Fish., Sea Fish. Res. Sta. Bull. 2: 6), we still know very little of its occurrence there. *C. isostigma* is not known from the Red Sea or the western Indian Ocean.

Dr. Kosswig stated in correspondence to me that *P. bipunctata* maintains a mode of life among the long-spined sea urchin, *Diadema*. The fish remains parallel to the spines, the head directed outward. The light spot at the base of the caudal fin (this light area surrounds a dark spot in preserved specimens) "corresponds very nicely to the interradial shining silvery spots of the sea urchin." Thus we find a pattern of horizontal stripes among closely related species, a blending of the pattern of such black-striped forms when in a vertical position with the long, purplish black spines of the sea urchin, and the blending of the light, peduncular spot of the fish with those of the sea urchin. Dr. H. A. F. Gohar, Marine Biological Station, Al Ghardaqa, informed Dr. Kosswig that striped apogonids are found "normally between the long, black spines" of *Diadema*. The significance of such coloration patterns can only be conjectured upon at this time.

The type specimens of *P. bipunctata* were taken at night in shallow water over a sandy bottom with a 100-foot drag net. The rarity of this species in collections may be associated with their close relationship with the sea urchin, a retreat which the hurried collector may not investigate. Not requiring the retreat or protection afforded by *Diadema* at night, or, since these sea urchins move about at night and it may be more difficult for the fish to remain in the area of the spines, *P. bipunctata* consequently is then probably more widely distributed. The spiny abode may again be occupied at the approach of daylight.—ERNEST A. LACHNER, *Division of Fishes, U. S. National Museum, Washington 25, D. C.*

THE OVIPARITY OF THE WHALE SHARK, *RHINEODON TYPUS*, WITH RECORDS OF THIS AND OTHER FISHES IN TEXAS WATERS.—On July 2, 1953, Captain Odell Freeze, of the shrimp trawler DORIS, out of Port Isabel, Texas, was fishing near the "Twenty-four Ten" Bank, off the coast of México. In one haul of his net he noticed an unopened egg case. Later he said: "I saw this thing in the net and, on picking it up, felt something kicking around in it. When I opened it with a knife, out flopped this little shark, very much alive." Freeze took his find to Stuart Adkins of Port Isabel, long interested in Texas fishes, who made the photograph (Pl. I) and identified the specimen as a whale shark, *Rhineodon typus* Smith, the smallest ever caught.

Captain Freeze told Mr. Adkins that an adult was seen on the surface a number of times in the area, presumably on the day that the egg case was discovered, and he estimated that it was longer than the 65-foot DORIS.

The taking of this egg case should settle the question of the oviparity of this great shark, which was hinted at by Southwell (Ceylon Adm. Rept. Mar. Biol., 1912: E44, E49), inconclusively discussed by Bigelow and Schroeder (1948, Fishes of the Western North Atlantic, Vol. I (Sharks), p. 188), and postulated by Gudger (1952, COPEIA (4): 266–7). Mr. Adkins reported that the embryo was 14½ inches long, overall. The dorsal surfaces were bluish-gray, with white spots; the ventral portion was white. The egg case, which measured 12 inches long, 5½ inches wide, and 3½ inches thick, presented every appearance of having been in the water for some time, one side of it being worn, as if by sand.

Incidentally, this adds another record of this species for the western Gulf of Mexico. Others are given by Baughman and Springer (1950, Amer. Midl. Nat., 44 (1): 127), Baughman (1950, Texas Jour. Sci., 2 (1): 121), Gunter and Knapp (1951, *ibid.*, 3 (1): 134), and in various unpublished progress reports made since 1951 by Stewart Springer, while aboard the U. S. Fish and Wildlife Service vessel OREGON. The following additional records are new. In January, 1953, Mr. Ernest Busker told the writer that he saw a whale shark feeding in the midst of a school of blackfin tuna (*Thunnus atlanticus*) off the coast of British Honduras, and Captain R. K. Masson, of the British Honduras

Young whale shark and egg case from which it was removed

PHOTO BY COURTESY OF STAR PRINTING, MILES CITY, MONTANA

A specimen of the pallid sturgeon held by Mr. Emil Knutson

Customs, mentioned that he had seen one some years ago off Zapatillo Cays, in the southern part of the colony.

Chub mackerel, *Pneumatophorus colias* (Gmelin).—In March, 1953, Mr. Adkins, a very keen and well-informed observer, sent the writer a sketch of a 7½ inch fish, with the comment "about 50 taken off Port Isabel on 3/26/53 in a shrimp trawl by the NEPTUNA in 35 fathoms." So well done was the sketch, and so clearly were the other diagnostic characteristics reported, that there was no difficulty whatever in identifying the fish represented as this species. So far as I am aware, this is the first record for Texas and the western Gulf of Mexico, although Rivas (1951, Bull. Mar. Sci. Gulf and Caribbean, 1 (3): 214) reported it from Garden Key, Florida, and Poey (1868, *Synopsis Piscium Cubensum*, p. 360) gave a description of a Cuban specimen under the name *Scomber species dubia*.

Bonefish (*Albula vulpes*).—The species is rare in Texas. Some years ago one was caught on the central portion of the coast (Baughman 1950, *loc., cit.*: 125), but no others have been reported. On October 22, 1951, Captain Marion Duzich, of the trawler MARION D, working 45 miles south of Port Aransas, caught one in his net at a depth of 116 feet.

Ablennes hians (Valenciennes).—One specimen was taken in August, 1951, from 9½ fathoms, east of Port Aransas, and constitutes a new Texas record.

Antennarius nuttingi Garman.—Specimens from 25 fathoms were secured three hours south of Port Aransas, on January 21, 1950, and others from 18 fathoms, southeast of Port Aransas, were taken August 28, 1950. So far as I know, these constitute a new record for the state.—J. L. BAUGHMAN, *Las Olas Oceanographic Foundation, Rockport, Texas.*

A RECORD-SIZE PALLID STURGEON, *SCAPHIRHYNCHUS ALBUM*, FROM MONTANA[1].—The largest sturgeon on record from Montana is that reported by Cope (1879, Amer. Nat., 13: 432–41). This was described as a 47-pound shovelnose, *Scaphirhynchus platorhynchus*, but was recently judged to be *S. album* by Bailey and Cross (1954, Mich. Acad. Sci., Arts, & Letters, 39 (1953): 169–208) because of its size. The specimen came from the Missouri River near Fort Benton. Bailey and Cross gave a more recent record of a pallid sturgeon from Fort Peck Reservoir collected by H. W. Newman in 1949. This specimen measured 58 inches in total length and weighed 31.5 pounds when fresh. Mr. R. W. Branum of the U. S. Fisheries Station in Miles City, called my attention to an even larger specimen (Pl. I) of the pallid sturgeon which was caught on July 24, 1950, by Emil Knutson in the mouth of the Tongue River near Miles City, Montana. A rod and reel equipped with a 20-pound test line and number 2 hook baited with a piece of shrimp was used. The fish was hooked in the mouth. This specimen had a total length of 66 inches and weighed 38 pounds; unfortunately it was not preserved.

While there are records of the shovelnose sturgeon from this part of the Tongue River, the large size and relatively sharp snout of this specimen strongly indicate it to be *S. album*.

Reports of other large specimens from the lower Yellowstone River and also from the Upper Missouri below Great Falls have been received, but we have not had the good fortune to measure any of the fish.

The three largest specimens of the pallid sturgeon on record have come from the Upper Missouri drainage within Montana.—C. J. D. BROWN, *Montana State College, Bozeman, Montana.*

RECORDS OF THE SNAKE MACKEREL, *GEMPYLUS SERPENS*, FROM THE WESTERN ATLANTIC.—The snake mackerel, *Gempylus serpens* Cuvier, is a fish that is easily recognized. Nothing else is at all likely to be mistaken for it. There is a photograph of one in Heyerdahl's *Kontiki* (1948–50), a book that was widely read, perhaps especially so by persons interested in the sea. The accompanying text gives an exaggerated impression of the rarity of this fish, which may, at least in part, account for the following two records of its capture being sent to the American Museum of Natural History, both substantiated by photographs. Occurrences of *Gempylus* are rare enough to make these worth publishing.

The first "was caught with an ordinary feather lure on a trolling line in approximate latitude 37° North and longitude 72° West, in daylight, about July 25, 1951," by Howard Kelly Seibels of Birmingham, Alabama. It was about 20 inches long. He was sailing back from Bermuda on his uncle's schooner. His uncle, Dr. Edmund B. Kelly of Baltimore, wrote Dr. E. W. Gudger about it and later gave me further particulars.

The second was taken by Eldon G. Cook, Chief Machinist Mate, U. S. N., aboard the U. S. S. EDWARD H. ALLEN "at 0030 hours [half hour after midnight] in the morning of January 16, 1954, trolling a 3½ ounce white feather jig astern my [his] ship. The ship was about midway between Gonaives, Haiti, and Guantanamo Bay, Cuba, in the Windward Passage [19°40′ North, 73°55′ West], making a speed of eight knots. There was a bright moon obscured by clouds." Mr. Cook kept this specimen in the ship's freezer and later presented it to the American Museum of Natural

[1] Contribution from Montana State College, Agricultural Experiment Station, Project No. MS 844, Paper No. 336 Journal Series.

History, where it is now AMNH No. 20155. It measures 25 inches in standard length, 28½ from tip of lower jaw to tip of caudal fin.

It may be noted that there were two (Pacific) Kon-tiki individuals. Both occurred on dark nights. One jumped aboard; the other struck and got its teeth entangled in a rope. It was assumed that lights on the raft were involved in both occurrences.

The hypothesis that this fish normally has a vertical migration, from the twilight zone at considerable depth by day, to at or near the surface at night, is probably correct; but does not preclude its sometimes occurring near the surface in daylight, as the first mentioned individual did. *Gempylus* probably is rather strictly pelagic and occurs singly and widely scattered. It is not often that methods likely to take such swift active fishes from the surface and sub-surface layer of the open ocean are employed, which may also account for the rarity of its capture. Special investigation of this habitat might uncover worthwhile facts about such fishes.

There is a published record of a *Gempylus serpens* 44 inches in total length "found cast up on the sea beach near the Nepeague Coast Guard Station, Long Island [N. Y.], by George H. Mulford, November 16, 1923" (Nichols and Breder, 1926, Zoologica, 9 (1): 125).—J. T. Nichols, *American Museum of Natural History, New York, N. Y.*

OCCURRENCE OF THE NINESPINE STICKLEBACK, *PUNGITIUS PUNGITIUS*, IN NEWFOUNDLAND, CANADA.—On August 2nd, 1951, a single specimen of the ninespine stickleback, *Pungitius pungitius* (Linnaeus), was collected along with Atlantic salmon parr, in the fresh waters of the Northwest Gander River, Newfoundland, approximately 30 miles from salt water. The collectors, Mr. G. B. Wiggins and Dr. C. W. Andrews, were employed by the Newfoundland Fisheries Research Station at the time. Although Halkett (1913, Check List of the Fishes of the Dominion of Canada and Newfoundland: 73) reported the occurrence of this species in "... Newfoundland and Labrador ...," there was no locality given, no specimens are available, and there have been no subsequent reports; therefore it is presumed that the species is uncommon in Newfoundland waters. The specimen is deposited in the fish collection of the Royal Ontario Museum of Zoology.—W. B. Scott, *Royal Ontario Museum of Zoology and Palaeontology, Toronto 5, Canada.*

RECORDS OF THE TADPOLE MADTOM, *SCHILBEODES MOLLIS*, AND THE BLACK BULLHEAD, *AMEIURUS MELAS*, FROM OREGON AND IDAHO.—Among fishes collected by Lawrence Bisbee in the Snake River drainage during the summer of 1953 was the tadpole madtom, *Schilbeodes mollis* (Herrmann), for which no previous definite Oregon records are known to us. Also taken was the black bullhead, *Ameiurus melas* (Rafinesque), which has been reported as occurring in this state by Griffiths (1940, Trans. Amer. Fish. Soc. 69 (1939): 240–3) and by Chapman (1942, Calif. Fish and Game, 28 (1): 9–15) without mention of definite localities.

Two specimens of the madtom, 24 mm. and 30 mm. long, and 15 young-of-the-year ranging from 9 to 11 mm. in length, were taken from a side channel of the Owyhee River at Owyhee Junction, four miles north of Adrian, Oregon, on August 11, 1953. The presence of this fish in Idaho was confirmed by information kindly supplied by Dr. Robert R. Miller, who wrote that the University of Michigan Museum of Zoology has specimens with the following data: UMMZ 136204: Snake River at Homedale Bridge, Homedale, Idaho; 2 young and 1 half-grown taken by Lyle M. Stanford on November 13, 1942. Mr. Forrest R. Hauck, of the Idaho Fish and Game Department, has written that he has records of the tadpole madtom from various points on the Boise and Snake rivers.

The black bullhead was taken from Dunaway Pond at Nyssa, August 8, 1953, the collection consisting of 11 specimens ranging from 31 to 44 mm. in length. This represents the first definite record known to us of this species in the Columbia River System in Oregon. Previous records for Oregon, supplied by Dr. Miller, are as follows: UMMZ 136689: 7 half-grown to adults from Chewaucan River at highway bridge NW of Valley Falls, Lake Co., taken by R. R. and R. G. Miller on June 28, 1939; UMMZ 136691: 4 half-grown to adults from a spring-fed ditch on Brattin Ranch, 2 mi. SE of Chewaucan River, at "The Narrows," Lake Co., seined on June 28, 1939, by R. R. and R. G. Miller; and UMMZ 138636: 3 yearlings from Chewaucan River South of Paisley, Lake Co., collected by Stanley G. Jewett, Jr. and Edwin Niska on September 21, 1940. This catfish has been verbally reported as occurring in Lake of the Woods, Klamath County, and McFadden's Swamp, Benton County, but extensive collecting in those two localities has not revealed any specimens. The presence of this species in Idaho is questionable, as Mr. Forrest Houck has indicated that only the brown bullhead has been definitely identified from that state.—Carl E. Bond, *Department of Fish and Game Management, Oregon State College, Corvallis, Oregon,* and Lawrence Bisbee, *Oregon State Game Commission, Hines, Oregon.*

Herpetological Notes

NOTES ON SNAKE ANESTHESIA.—Brazenor and Kaye (1953, Copeia (3): 165–70) described a method by which they anesthetized certain Australian snakes and lizards with ether vapor. It has been the authors' experience that gaseous ether is relatively difficult to administer, dosage is hard to control, and snakes may go into contortions while submitting to its effects. Instead of ether we recommend the use of certain other standard anesthetics, at least one of which is currently used as a killing agent by many herpetologists. Information concerning reptile anesthesia is scarce in the literature, and we hope the following information may be of value to anyone finding it necessary to temporarily immobilize snakes.

Three anesthetics, Pentothal Sodium (thiopental sodium), Nembutol (pentobarbitol sodium) and M.S 222 (tricaine methanesulfonate) have been used. Dilutions to proper concentration, varying according to the size of the snake and the anesthetic employed, were made with cold-blooded Ringer's solution. The juvenile snakes (5–10 g.) each received less than 1 cc. solution, and the largest individuals (200–370 g.) were injected with upwards of 5 cc. The snake was held behind the head with forceps or by hand, and the tail was pinned to the floor by a firmly planted foot. In this manner one person can stretch the snake out full length and make the injection with his free hand. We made all injections ventrally into the middle part of the pleuroperitoneal cavity, taking care to avoid the pericardial region. Complete loss of the righting reflex was the criterion used for the anesthesia period, i.e., the time following injection required for the reptile to yield fully to the effects of the anesthesia. The recovery period is the approximate time it took for the snake to right itself after first showing loss of the righting reflex. In our experiments no means of artificial respiration, such as the administration of oxygen, were employed. All experiments were carried out at room temperature, 68°–72° F. Higher temperatures have a pronounced effect on the rate of recovery. One of us (Cook) injected juveniles of *Crotalus* with dosages previously determined sufficient to keep them immobilized for 2 to 6 hours. However, when the snakes were placed beneath photographer's flood lights exposing them to temperatures above 100° F., some of them recovered within 10 to 15 minutes.

We have summarized part of the results obtained from the anesthetization of 26 snakes representing seven species (Table I). We gained much of our information independently and incidental to other problems. Therefore, we did not, in most cases, record with a high degree of accuracy the anesthesia and recovery periods. Many snakes revived during the night and morning hours when we were absent from the laboratory; therefore, the recovery times (Table I) are generally too high. We were interested primarily in fairly rapid, effective anesthesia and normal recovery of our specimens. That we were successful in this regard is attested by the fact that all our snakes (with the exception of those purposely given excessive quantities to determine lethal dosages) fully recovered. Certain individual snakes were anesthetized two or three times without apparent ill effects.

One of us (Karlstrom) sought information concerning the respiratory cycles of *Natrix taxispilota*

TABLE I

RESULTS OBTAINED FROM THE ANESTHETIZATION OF 26 SNAKES

Di = dosage insufficient to effect loss of the righting reflex; Le = dosage lethal; Nr = time interval not recorded

Species	Wt. (gms.)	Dosage (mgm./gm. snake)	Anesthesia period (min.)	Recovery period (hrs.)
PENTOTHAL SODIUM				
Natrix taxispilota	209.7	.014	Di	..
Natrix taxispilota	308.6	.016	35	1½
Natrix taxispilota	213.7	.019	45	6
Natrix taxispilota	199.4	.025	25	Nr
Thamnophis sirtalis	250.6	.011	25	1½
Thamnophis sirtalis	85.3	.023	30	2
NEMBUTOL				
Diadophis amabilis	8.0	.050	5	18
Diadophis amabilis	8.0	.100	Nr	Le
Thamnophis elegans	10.0	.030	5	6
Pituophis catenifer	414.0	.015	Di	..
Ancistrodon contortrix	5.5	.015	9	12
Ancistrodon contortrix	5.7	.030	5	45
Ancistrodon contortrix	5.8	.045	5	48
Ancistrodon contortrix	5.4	.060	2	Le
Crotalus viridis	9.4	.030	5	54
Corotalus viridis	8.9	.015	9	10
Corotalus viridis	8.4	.045	5	72
Crotalus viridis	9.1	.060	2	Le
Crotalus viridis	253.0	.030	27	5½
M.S. 222				
Pituophis catenifer	369.5	.040	Di	..
(Same snake)		.216	50	2
(Same snake)		.271	17	12
Thamnophis elegans	147.6	.405	12	Le
Ancistrodon contortrix	6.5	.115	Di	..
Ancistrodon contortrix	5.5	.272	9	15
Ancistrodon contortrix	5.7	.438	5	19
Crotalus viridis	8.4	.178	9	4
Crotalus viridis	9.4	.266	5	4
Crotalus viridis	8.9	.561	4	Le

and *Thamnophis sirtalis*. In order to get the animals into the plethysmograph (a long glass tube with a rubber cuff at the end fitting snugly around the snake's "neck"), it was found expedient to anesthetize them first. On the basis of his own physiological experiments with reptiles, Dr. Arthur W. Martin of the University of Washington Zoology Department suggested the use of Pentothal Sodium at a dosage of .025 milligram per gram weight of snake. It was desirable in this experiment to have the snakes recover as rapidly as possible while set up in the respirometer. Hence, minimal dosages of less than .025-mgm./gram-weight-of-snake were usually given. In addition, the snakes were exercised immediately following injection by forcing them to move about on the laboratory floor. The results (Table I) indicate that these snakes recovered faster than those given corresponding doses of either Nembutol or M.S. 222. It is not known whether the exercise had any appreciable effect on the time required for the snakes to "go under," but the exercise and handling may have influenced the rate at which the effect of the anesthetic wore off. All other snakes reported, excluding *Natrix taxispilota* and *Thamnophis sirtalis*, were simply placed immediately in open jars or cages following the injections.

Nembutol has a potency comparable to Pentothal Sodium, according to our findings. In any case, it is difficult to predict the effect of any single dosage on a particular snake. Many factors must be taken into account: size and individual physiology of the snake, its condition at time of injection, room temperature, site of injection, degree of handling of the animal, etc. The juveniles of *Ancistrodon* and *Crotalus*, for example, had not fed for an extended period prior to their use in our experiments and their condition may be reflected in the relatively long recovery periods recorded for them.

Many herpetologists successfully anesthetize amphibians through the skin by immersing them in a solution of M.S. 222. Our results indicate that this drug also may be successfully employed by injecting it into reptiles. The anesthesia and recovery periods are similar to those for snakes injected with Pentothal Sodium or Nembutol. One advantage of M.S. 222, particularly where small reptiles are involved, is that the dosage may be more easily controlled because larger amounts of the substance are required. However, on the basis of our experience, all three anesthetics yield similarly good results, and we cannot definitely rate any one as superior to the others.

Brazenor and Kaye (*op. cit.*) suggested that anesthesia in reptiles, which lack a diaphragm, necessarily involves respiratory arrest and enforces a technique of artificial respiration. These workers were concerned with making latex casts from living animals, and it was necessary to subject their specimens to a deep plane of anesthesia. They chose gaseous ether as their anesthetizing agent, following it later with oxygen to insure recovery of their animals. We suggest that intrapleuroperitoneal injections of Nembutol, for example, would give as good results without the necessity of administering any form of artificial respiration whatsoever. Such injections are simple to give, require a minimum of apparatus, and the dosage can easily be controlled. Undoubtedly there are numerous other anesthetics available that could be adapted equally well or better for anesthesia of cold-blooded vertebrates.

We wish to express our thanks to Dr. Robert C. Stebbins who kindly read the manuscript.—E. L. Karlstrom and Sherburne F. Cook, Jr., *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

METHODS FOR MEASURING CROSS-SECTION AND VOLUME IN TURTLES.—In the course of work on relative growth in three species of turtles, *Graptemys geographica*, *Chrysemys picta* and *Sternotherus odoratus*, I have been confronted with the problems of measuring volume and cross-section. The following techniques were devised and seem of sufficient usefulness to warrant their description.

Cross-section.—For measuring cross-section, a wire (No. 20 soft copper) is pressed about the animal and twisted tightly with pliers. It is then carefully removed and placed on a sheet of soft carbon paper over stiff paper. Next, the wire form is covered by a flat square of masonite and pressed firmly, leaving the impression of the turtle's cross-section on the stiff paper (Fig. 1). Details too fine to be obtained by the wire may be drawn in with pencil on the carbon impression.

At times, particularly when measuring preserved specimens with stiffly projecting limbs, difficulties were experienced in removing the wire. When distortion was suspected, the height and width of the wire form were measured and compared with actual measurements of the specimen. Cutting the wire for removal and rejoining the ends was necessary for only one individual (a specimen of *Chelydra serpentina*) in the course of measuring 280 turtles representing 28 species and including about 40 preserved individuals. Wire measurements were most easily secured when taken in the region of the bridge. The mid-point of the bridge was chosen as a standard point of reference.

Volume.—In measuring the volume of a living turtle by displacement of water, there are many sources of error due to the animal itself. Extension

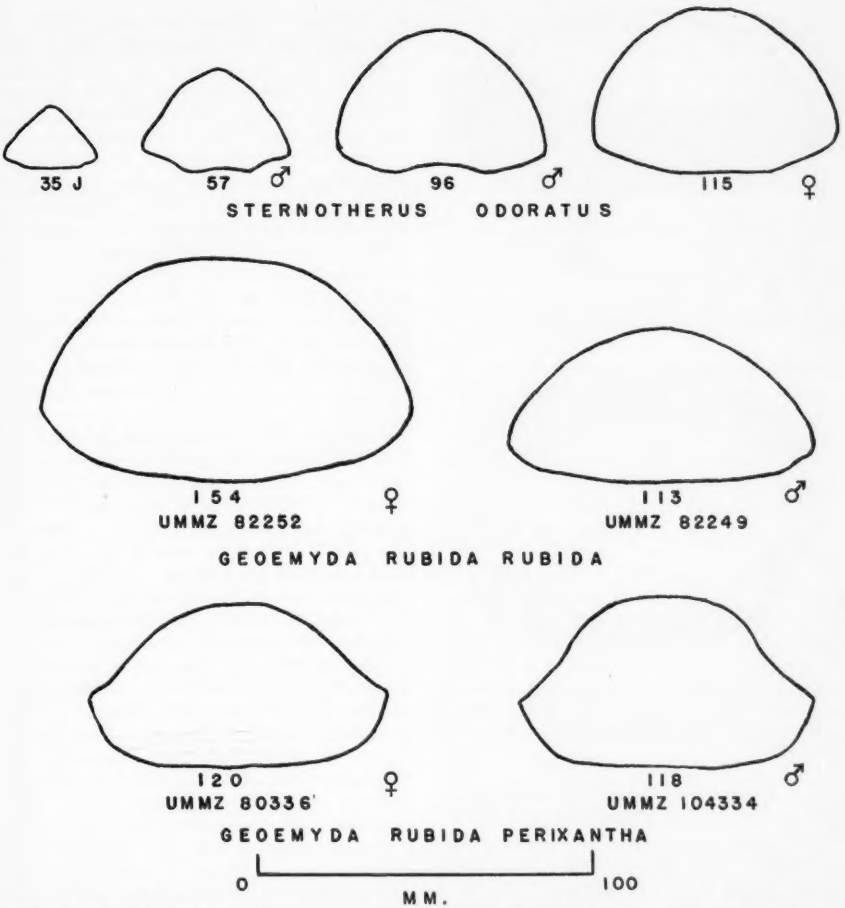


Fig. 1. Illustrations of possible uses of cross-sections. Ontogenetic change is shown in *Sternotherus odoratus*, although the range of variation for each size given here is not shown. Taxonomic differences are shown between two subspecies of *Geoemyda rubida*. Numerals immediately below each outline are carapace length in mm. UMMZ = University of Michigan Museum of Zoology.

or withdrawal of the neck and limbs, inflation or deflation of the lungs, swallowing of water, and, in particular, excessive activity of the animal all make determinations difficult and contribute inaccuracies. Although some or all of these may be eliminated by killing or anesthetizing the subject, I have found that the following method reduces these errors and at the same time affords a consistent measurement of the volume of the shell. An ordinary toy balloon is inflated, placed over the plastron, and then simultaneously deflated and pressed about the shell (Fig. 2). In this way, a water-tight fit is obtained which makes it possible to measure the enclosed volume. The neck of the balloon is held against the shell with a rubber band. Many of the turtles covered in this manner remain inactive until the balloon is removed by inflation.

In measuring the volumes of 240 painted, musk-, and mapturtles with carapace lengths up to 207 mm., I found it necessary to use only three sizes of balloons. One balloon was made to fit turtles of various sizes by increasing or decreasing inflation before pressing the balloon over the turtle. A loose fitting application was often adjusted satisfactorily by pulling the balloon slightly off the turtle. With careful work, and cooperation on the part of the turtles measured, a single balloon may be used repeatedly.

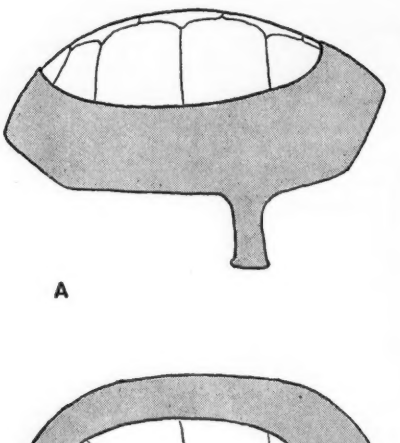


Fig. 2. A—Lateral view of a musk turtle with balloon applied. The neck of the balloon may be pressed to the plastron with a rubber band. B—Dorsal view.

The application of the balloon to the animal requires some practice although it is not difficult. Problems of application varied with the species and individuals studied. The serrate rear of the carapace of the map turtle, and the steep sides without a flared rim of the musk turtle, presented different problems. Some times two balloons were used, one over the anterior and one over the posterior halves of the animal. To eliminate biting in more aggressive individuals, the head was pushed in with a piece of dampened paper before applying the balloon. Active turtles were often quieted by sharp blows with a pencil to the head and limbs. Bits of dampened paper were also used under the rear end of the carapace in young turtles, to prevent distortion under pressure of the balloons. The application of balloons to hatchlings was not attempted. These were measured by simply dropping them into a graduated cylinder.

The balloon-encased turtle is placed in a can with an overflow spout and immersed by means of a wire tripod. The displaced water is caught in a graduated cylinder. By greasing the spout heavily, the drip of water is cut to a minimum and the time for measuring considerably shortened. Thus far I have used four cans of various sizes, always submerging the animal in the smallest possible can. Reduction of surface tension by adding detergent to the water was attempted, but this was abandoned because the time of dripping was lengthened.

Besides using balloon-covered turtles in measuring volume by immersion in water, plaster casts were made of a few. The use of the balloon in this approach quiets the turtle and makes possible a simple two-piece mold by eliminating the various overhangs and hollows at the limbs and neck. However, casting the mold and filling it with lead shot or some other material to measure the volume is far less efficient and far more time consuming than simple water displacement as a method and has little to recommend it in measuring large numbers of turtles.

Remarks.—The balloon technique for measuring turtle shell volume can be used in measuring living turtles, and shells prepared as skeletons. However since it requires flexibility of limbs, neck and tail t is not applicable to the majority of preserved specimens. Also it is not feasible for measuring species in which the carapace or plastron is not rigid, nor for measuring extremely large individuals. It is of doubtful applicability in the case of aggressive species such as *Chelydra serpentina*.

The cross-section measurement is of more general utility. From the impressions obtained, the cross-sectional area of the turtle can be determined with a suitable mechanical integrator. The circumference can be obtained with a chartometer or "map wheel" and height and width may be measured with ruler or calipers. Measurements of angles of various slopes are facilitated by this method.

Ontogenetic changes in shape as well as taxonomic differences can be shown in cross-section. As a specific example of the use of cross-sectional measurements in taxonomy, four individuals of the turtle *Geoemyda rubida* are illustrated (Figure 1). This species is represented by two subspecies (1953, Mosimann and Rabb, *Occ. Pap. Mus. Zool. Univ. Michigan*, No. 548). In dividing the species into two subspecies the projection of the marginal scutes was used as a diagnostic character and expressed mathematically. This could have been well illustrated by use of cross-sections. Furthermore these cross-sections show clearly another character, the relative bulk of the turtles above the rim of the carapace.

Obviously, mathematical expressions such as height-width ratios and marginal flare indices are of value in allowing quantitative treatment; however, cross-sections as illustrated here express the above relations and are at least of supplementary use in describing them.

I am indebted to Dr. Norman Hartweg for comments and suggestions, and to Dr. C. F. Walker for critically reading the manuscript.—JAMES E. MOSIMANN, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

ALGAL GROWTH ON THE TURTLE *CHRYSEMYS PICTA PICTA*.—A female painted turtle, with a carapace length of 109 mm. was collected by the writer near his home in Hamden, Connecticut, fully a quarter of a mile from the nearest body of water, on September 27, 1953. It had an algal growth that formed a half circle around the posterior part of the carapace, reaching from central scute No. 4 to marginal 7, embracing half of lateral 3 and all of lateral 4. There was a small, isolated amount on a somewhat damaged section of marginal 3. The algae were so desiccated at the time of capture as to indicate that the turtle must have been out of the water for several days. The algae have been identified as *Basicladia crassa* Hoffm. and Tild.

On March 28, 1954, in a small pond in Hamden, the writer collected two more females of *Chrysemys p. picta*, each with a sparse growth of algae on the carapace. The algal growth sparingly embraced the rear laterals and marginals of the shells.

The subject of algal growth on North American turtles has been reviewed by Walker, Green, and Jones (1953, COPEIA (1): 61), and by Edgren, Edgren, and Tiffany (1953, Ecology, 34 (4): 733). Both articles mention that *Chrysemys picta marginata*, and *C. p. belli* have been reported in connection with this subject. Both of these subspecies are also partial to shallow, quiet waters.

The writer wishes to express his appreciation to Prof. William Randolph Taylor, University of Michigan, for kindly identifying the algae.—HENRY MOSKI, *20 St. James St., Hamden 14, Connecticut.*

POSTURE OF CHILLED NEWTS (*DIEMYCTYLUS VIRIDESCENS LOUISIANENSIS*).—On November 21, 1951, I was collecting in Toombs County, Georgia, where U. S. Highway No. 1 crosses the Altamaha River. Pools of the river bottomland are normally full of water at this season, but on that date they were nearly or quite dry. During the previous night the temperature had dropped rapidly almost to the freezing point, and it had not risen much during the morning. Beneath logs and boards on the pond bottoms were about two dozen Louisiana newts (*Diemyctylus viridescens louisianensis*). They had recently transformed from the terrestrial eft to the aquatic adult, as evidenced by size and ventral coloration. All were thoroughly chilled and apparently incapable of crawling. Each specimen, when disturbed, bent its head and tail upward so that the two nearly touched. The tail was curled into a spiral, plainly revealing the orange-red under surface. The limbs were flexed, and the eyes were closed and depressed into their sockets. Most of the newts rested not on the belly but on the gular surface, chest, and flexed forelimbs. They were able to maintain this posture because of supporting grass blades, clods of earth, twigs, and other ground debris. Upon examination, the gular area proved to be contracted.

Stebbins (1951, Amphibians of Western North America: 18) described very similar behavior in a California newt, *Taricha granulosa*. However, in his specimen the legs were extended stiffly from the body. Stebbins did not state whether the newt was chilled.

I have collected many other Louisiana newts, both efts and adults, but never observed any unusual behavior. The contorted posture, described above, may help to discourage would-be predators when the salamanders are cold and almost helpless. —WILFRED T. NEILL, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

THE OCCURRENCE OF THE LIZARD *CNEMIDOPHORUS SEXLINEATUS* IN NEW MEXICO.—A paper by the author in press (Ecology) reports on lizards new to the herpetofauna of New Mexico which occur in the extreme southwestern corner of the state. These are discussed in relation to the problem of the eastern limit of the Sonoran Desert in the United States. The nature of the report is such that it does not treat an eastern species of *Cnemidophorus* recently discovered to occur in the northeastern part of this state.

Two adult specimens of *Cnemidophorus sexlineatus*, the Eastern race runner or whiptailed lizard were collected by the author on August 13, 1949, in Quay County, New Mexico. One specimen was taken at 5.0 miles, and the other at 7.6 miles, south of Tucumcari, along state road 18. They are Nos. 4660–61, respectively, deposited in the collection of the Zoology Department of the University of California, Los Angeles.

Both specimens were a conspicuous green when alive. Dr. T. Paul Maslin of the University of Colorado has informed me that specimens from Colorado are also green. It appears that these western individuals may be representative of a distinctive allopatric variant in this widespread species currently treated as monotypic.

Six species of *Cnemidophorus* are now known from New Mexico (apparently a seventh occurs and will be reported upon subsequently) as follows: *C. inornatus, C. neomexicanus, C. sacki, C. sexlineatus, C. tesselatus* and *C. tigris*. Specimens of all were collected in New Mexico by the author, R. G. Zweifel, and K. S. Norris during 1947–50. The majority of these specimens are also in the

collections of the Department of Zoology, University of California at Los Angeles.—CHARLES H. LOWE, JR., *Department of Zoology, University of Arizona, Tucson, Arizona.*

TAXONOMIC AND PHYSIOLOGICAL FACTORS IN THE EMBRYONIC DEVELOPMENT OF CERTAIN TOADS.—Volpe (Physiol. Zool., 26 (4), 1953) published data showing that some toad embryos from different regions differ in survival and in developmental rates under experimental conditions, whereas others do not. Toads which he called *Bufo americanus* from various regions of the North and East differed greatly from *Bufo americanus* from Oklahoma; and *Bufo fowleri* from various sources differed significantly from so called *B. fowleri* from Louisiana. But, except for these, all other toads used had a constant survival and growth pattern for each species regardless of source. *Bufo woodhousei woodhousei* from Oklahoma, Kansas and Texas all showed the same pattern, just as *B. americanus* (except from Oklahoma) and *B. fowleri* (except from Louisiana) did. Relying partly on J. A. Moore's work with the leopardfrogs (Evolution 3, 1949, and elsewhere), Volpe interpreted these results in each variant case as adpatations to survival in different environments on the part of a single species (perhaps of a single form).

Whereas I have no quarrel with this interpretation, I do wish to point out that Volpe's data seem clearly to indicate a slightly broader interpretation based upon current findings in the taxonomy of the animals involved. The toad in Louisiana usually identified as *B. woodhousei fowleri* Hinckley is in reality *B. w. velatus* Bragg and Sanders or an intergrade between this and *B. w. fowleri* Hinckley. Similarly, the dwarf American toad of Oklahoma belongs to a distinct subspecies just being described by me in a paper now in press. Since these are the very ones that varied in Volpe's findings, whereas no others did so, his data really show that the taxonomic distinctions claimed on other grounds are probably valid. Volpe's physiological data support the subspecific differentiations which were arrived at on morphological grounds before these physiological facts were known.

This conclusion does not conflict at all with Volpe's interpretation of different adaptation of different populations within a *species;* it merely carries the conclusion of a step farther, and recognizes the differences found as occurring within distinct *sub*species in each case. In other words, the adaptations of the Oklahoma and Louisiana populations of *B. terrestris* and *B. woodhousei*, respectively, are associated with other (morphological) characters sufficiently distinct to warrant subspecific status.

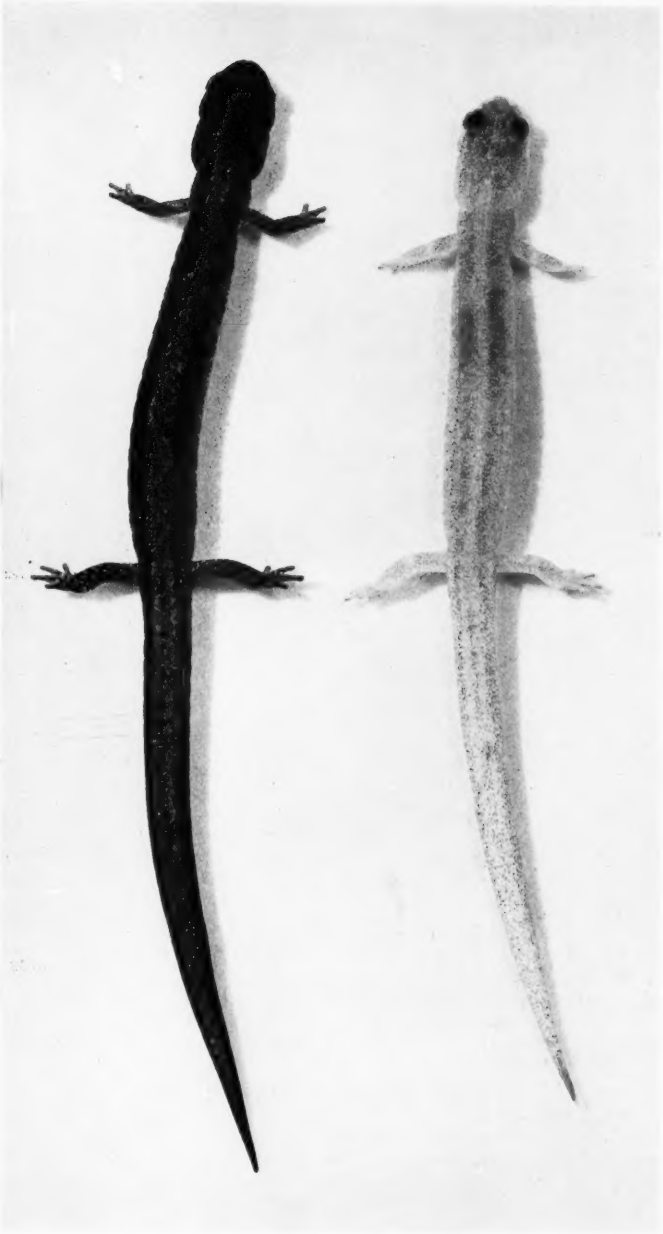
I have long suspected this to be the case also in the leopardfrogs studied by Moore (*loc. cit.*) but have not proved this to be so.—ARTHUR N. BRAGG, *Department of Zoological Sciences, University of Oklahoma, Norman, Oklahoma.*

AN ALBINISTIC INDIVIDUAL OF THE SALAMANDER *PLETHODON DORSALIS*[1].—An albinistic *Plethodon dorsalis* Baird was collected along with two normal individuals from a woodpile along a ridge about 5 miles east of Bloomington, Monroe County, Indiana, on April 28, 1953. To my knowledge it is the first such individual of its species to be recorded.

The salamander appears normal in all respects except pigmentation, although it is not a complete albino (Plate I). The eye pigmentation is approximately normal and apparently includes guanophores (iridocytes) and "lipophores" in the iris as do other Indiana individuals. All three skin pigments are present, though greatly reduced in intensity. Either the amounts of these pigments in the cells, or the cells themselves, are abnormally small. The distribution of the pigment intensity is more normal. Melanophores appear as a very fine stippling all over the body, heaviest just lateral to the dorsal stripe area and lightest on the venter. "Lipophores" are absent from the flanks and venter, unlike normal *dorsalis*, and appear only as a very faint orange dorsal stripe. This suggests a curtailed migration of the cells, as do the intensity of the color and the shape of the stripe, the pigment being heaviest in the lobes (not distinct in Plate I) which project from the dorsal stripe. I have noticed a similar condition in some first-summer young (the so-called "juvenile spots"), but never before in *dorsalis* of this size (total length 71.9 mm., snout-to-vent length about 35 mm.). Only a few faint small guanophores were seen, all of these in the gular region against the red background of the heart. The same area shows about the heaviest guanophore concentration in normal *dorsalis*. The gross appearance of the animal is white and translucent; the blood vessels and viscera are clearly visible through the skin and appear normal in color.

The physiological genetics of such a phenotype in salamanders is unknown. In the terminology commonly used in reference to guinea pigs, a "C" type of locus could be involved, since all three pigments are affected. The effect is quantitative, since all the usual types of pigment cells are differentiated and functional. Some change in the biochemistry of the developing embryo is apparently indicated, which reduced the number of pigment cells produced and/or their development, or reduced the amount of a substrate necessary in

[1] Contribution No. 530 of the Zoological Laboratories, University of Indiana.



Albinistic (right) and normal (left) specimens of *Plethodon dorsalis*

Apparatus for collecting venom of *Heloderma*. *Upper:* stender dish with two sections of bicycle inner-tube pulled over the mouth of the glass. *Lower:* rubber extensions in place and apparatus in use.

pigment production. The picture here may be similar to that given by Wright's theory concerning the physiological effect of the albino series of alleles in guinea pigs (1925, Genetics, 12: 223–60). However the sharp contrast between the pigmentation of the eye and of the skin suggests that the gene or genes involved may have secondarily affected only the skin rather than the pigment cells in general.

An interesting point in connection with population genetics is the association of this deviant form with the extreme headwaters of a stream system. I do not yet have convincing evidence, but I believe that *dorsalis* is generally restricted to stream-lowland areas rather than the better-drained interstream areas, and that its dispersal may follow drainage patterns. If this is true, there is a possibility that this "terminal" local population is more isolated than other populations occurring farther downstream. Under these conditions the population is more likely to accumulate mutant genes, since mutation pressure becomes greater relative to effective selection pressure in populations of small size.

I am indebted to Mr. C. Flaten of the University of Indiana Photographic Laboratories for the photograph reproduced here.—GORDON R. THUROW, *Department of Zoology, University of Indiana, Bloomington, Indiana.*

TECHNIQUE FOR OBTAINING MAXIMUM YIELDS OF FRESH LABIAL GLAND SECRETIONS FROM THE LIZARD *HELODERMA SUSPECTUM*.—In recent studies of the labial gland secretions of the Gila monster, *Heloderma suspectum*, it has been found that earlier techniques for procuring samples are unsatisfactory. The procedure of Mitchell and Riechert (1883, Medical News Philadelphia, 42 (8): 209–12), the first devised, involves injury to the animals and contamination of the sample. The lizards were caused to bite saucers and the intensity of the bite broke teeth, caused bleeding, and the secretions were thus contaminated with blood and broken-down cellular products. The method of Santesson (1897, Nordiskt Medicinskt Arkiv. Testband tillegnadt Axel Key, Nr. 5) has not been used because it is impossible in this procedure to separate the secretions from the upper and lower jaws. Santesson induced the animals to chew on sponges. The secretions were recovered by washing with a physiological salt solution. The resulting unknown dilution factor and unknown amount of yield are undesirable. Van Denburgh (1898, Trans. American Philosoph. Soc., 14: 199–220) and Van Denburgh and Wight (1900, American Jour. Physiol., 4(5): 209–38) merely substituted materials that the lizards were caused to bite. In these experiments filter paper and rubber were the substances used. The method of Loeb et al. (1913, Carnegie Inst. Washington Publ., No. 177) represents a more acceptable technique. The animals were induced to chew on soft rubber while the labial secretions were pipetted away from the lower jaw. The secretions of the upper and lower jaws were separated and injury to the animals was minimized, but the yield was relatively modest and the procedure somewhat complicated.

The technique developed by us involves the use of an easily assembled, simple apparatus. The yields of secretion are high, contaminants are minimized, and the animals are not injured. The procedure is both a field and laboratory technique that is direct, rapid and foolproof.

The venom collecting apparatus consists of the ordinary tall stender dish, approximately 3 inches high and 2½ inches in diameter, and two sections of bicycle tire inner-tube. Two or more thicknesses of the innertube are fitted over the mouth of the stender dish and allowed to extend 2 inches below the rim (Pl. I, upper). The sections of tubing are permitted to extend approximately 2 inches above the rim of the glass. By forcing these projecting sections of the tubes down into the stender, a lining is formed composed of two thicknesses of rubber both inside and outside of the glass. Adjustments can be effected by slitting the *inner* rubber wall to secure a good fit.

The Gila monster is made to bite the rubber-covered rim of the stender dish so that the lower jaw is on the inside of the container (Pl. I, lower). To assist in effecting the initial bite and hold by the animal, it may be tapped on the snout until it opens its jaws widely; when this happens, the rubber-rimmed stender is quickly and carefully thrust into the mouth and then set upright on a flat surface. There is no injury to the teeth or mouth; and the secretion flows freely down the inside of the rubber lining and the glass, and collects in the bottom of the dish. Teasing the animal usually intensifies the biting and chewing reaction and increases the yield of the labial gland secretions. Single yields of as much as 1.0 ml. can be expected from animals in excess of 300 mm. snout–vent length. After a few minutes of biting, the lizard is ready to completely release its hold.

While using the present technique, as described above, we have concomitantly applied electrical stimulation to areas of the body and head, especially the lips, but this has not given a significant increase in yield of venom.—WILLIAM H. BROWN AND CHARLES H. LOWE, JR., *Department of Zoology, University of Arizona, Tucson, Arizona.*

ESTABLISHMENT OF THE TEXAS HORNED TOAD, *PHRYNOSOMA CORNUTUM*, IN FLORIDA.—The Texas horned toad

has been reported in Florida on several occasions. De Sola (1934, COPEIA (4): 190) noted the presence of this species at Miami, Dade County. Residents of the area stated that the reptiles were to be found in sandy lots. Apparently De Sola saw four examples. Goff (1935, COPEIA (1): 45) examined four horned toads from the vicinity of Leesburg, Lake County. These were collected in 1931 and 1934; there were also reports of *Phrynosoma* in the Leesburg area during 1932 and 1933. Carr (1940, Univ. Florida Pub., Biol. Sci., Ser. 3 (1): 45) saw two horned toads reputedly from an orange grove in Winter Park, Orange County. He also mentioned a specimen from Santa Rosa Island, Escambia County, and another taken in 1935 at Palatka, Putnam County.

In recent years we have heard nothing of *Phrynosoma* at Miami. Increasing urbanization may have exterminated the supposed colony, as it did some colonies of native reptiles such as *Gopherus polyphemus*. Specimens have not been taken lately in Orange, Escambia, or Putnam County, as far as we know. However, the presence of horned toads at Winter Haven, Polk County, has been rumored; and we received one specimen collected at Vero Beach, Indian River County, in September, 1953.

There have been no recent reports of horned toads in the immediate vicinity of Leesburg. However, in 1952 the lizards made their appearance near Belleview, Marion County, about 18 miles north-northwest of Leesburg; and also near Martel, Marion County, about 33 miles northwest of Leesburg. Local residents collected three *Phrynosoma cornutum* at as many different localities within a 6-mile radius of Belleview. The creatures had not been seen there before. A single specimen was found by a rural resident in turkeyoak woods near Martel. This example and one of the Belleview lot are now in our preserved collection.

Martel, Belleview, and Leesburg are roughly aligned, in a region of rolling sand hills. These hills are covered with turkeyoak and longleaf pine, or else with rosemary scrub. Both plant associations present many open spots, where the surface sand is dry. Some of the hills have been cleared, and are now covered with broomsedge fields, tung orchards, or orange groves. Characteristic reptiles of the sand hills include *Cnemidophorus sexlineatus*, *Coluber f. flagellum*, *Pituophis melanoleucus mugitus*, *Heterodon simus*, *Crotalus adamanteus*, and *Gopherus polyphemus*. At least superficially, the area looks as though it might support *Phrynosoma cornutum*. Another Texas immigrant, the nine-banded armadillo, is now abundant in Marion and Lake counties (Neill, 1952, Ecology 33 (2): 282).

It is possible that colonies of horned toads were planted by grove owners, in the belief that the reptiles would keep down insect pests. Thus it remains to be proven that *Phrynosoma* is actually breeding in the Martel-Leesburg region.

The Texas horned toad is well established in at least one Florida locality: Fort George Island in Duval County. This is not an offshore island but a part of the mainland, bordered on the east by the Atlantic Ocean and elsewhere by swamps and streams. Much of the island is low and swampy, probably unsuitable for *Phrynosoma*. However, high sand dunes are present at one end of the island, and there the lizards are abundant.

The presence of *Phrynosoma* on Fort George Island was first noted by John W. Griffin, of Florida State University. He saw one adult there in 1946. In 1951, Mrs. Carita D. Corse informed us that the species was often captured there by small boys. She very kindly procured two half-grown specimens for our collection. Trips to the locality, in September, 1953, revealed the lizards to be thriving. Eight adults and five hatchlings were eventually secured. Residents of the island were familiar with the species, but did not inform us as to the origin of the colony.—E. ROSS ALLEN AND WILFRED T. NEILL, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

NORTHERN AND SOUTHERN RANGE LIMITS OF DUNN'S SALAMANDER, *PLETHODON DUNNI*.—Stebbins (1951: 68) cited two Washington localities for this plethodontid, both of which are immediately north of the Columbia River in western Washington. The most northerly of these is 6.3 miles southeast of Cathlamet, Wahkiakum County. On August 20, 1953, I collected three individuals of this species, 7.4 miles, by road, southeast of South Bend, Pacific County, Washington (Oregon State College Museum of Natural History (OSCMNH) Nos. 9338–9340). This locality is approximately 60 miles northwest of the Wahkiakum County record. The salamanders were under well imbedded rocks, about 4 feet from the water's edge, along the base of the steep bank of a small stream. The area was well shaded by alders and second-growth hemlock, and many of the rocks were overgrown with moss. The snout–vent lengths of the three salamanders are 28, 38, and 66 mm. There is no apparent difference between these salamanders and specimens collected near Corvallis, Oregon. Of considerable further interest is the fact that two individuals of *Plethodon vandykei* (OSCMNH 9336 and 9337) were collected under rocks within 2 or 3 feet of the *P. dunni*, there being no obvious difference in the requirements of the two species at this point. This appears to be the first record of sympatric occurrence of these two forms.

Those who use Robert Stebbin's book on western amphibians may have noted that, concerning *Pleth-*

odon dunni (p. 68), he gives the range as "from the Rogue River Basin, Curry County, in the southwestern part . . .," the Rogue River Basin being indicated as the southern limit of the distribution. On the other hand, his distribution map (p. 494) shows a collection locality at the Oregon-California line, which is a point some 20 to 30 miles south and west of the Rogue River drainage. This map record is based on 6 adults of *Plethodon dunni* (OSCMNH 5526–5531) collected on March 20 and 21, 1951 by members of the Oregon State College Museum of Natural History. The locality is at the Westmoore Guard Station, 7¾ miles by road up the Winchuck River from U. S. Highway 101, Curry County, Oregon. Two of the salamanders were taken from beneath shaded moss-covered rocks at the edge of a tumultuous mountain brook; and four were collected among small stones and gravel in a spring seepage of the well shaded east slope at the edge of the Guard Station clearing. This record was sent to Dr. Stebbins at a stage in the publication of his book when he was able to include it in his distribution maps, but not in the text.—ROBERT M. STORM, *Department of Zoology, Oregon State College, Corvallis, Oregon.*

EGGS OF THE SALAMANDER *PLETHODON DUNNI* IN NATURE.—Herpetological literature contains no reference to the eggs of *Plethodon dunni* having been found in nature. On July 6, 1952, a grape-like cluster of nine eggs was found attached by a 3.9-mm. stalk to a small slab 15 inches back in a crevice of a shale outcrop. The outcrop was on a heavily shaded southwest slope, about 6 feet from Sugarbowl Creek, Lincoln County, Oregon. The temperature in the crack was 13° C., and the relative humidity was 93 per cent. A female of *Plethodon dunni*, found within a few inches of the cluster, was flaccid but not emaciated. The diameters (in mm.) of the eggs, including the outer jelly capsule, were 5.3, 5.3, 4.8, 5.1, 5.1, 5.1, 5.2, 5.0 and 4.9. The egg cluster and the slab were moved to the laboratory, placed in a refrigerator, and kept at the same temperature and relative humidity as that found at the collection site. The female was placed with the eggs, but, since she failed to show any obvious response to them, was removed after 2 days. By August 4 the embryos were plainly visible, and by September 10 the head, eyes, tails, limbs and trunk were well developed. At this time, mold, which had been flourishing in the cluster despite repeated fungicide treatment, caused the destruction of the final embryo. This final victim had a snout–vent length of 16 mm. Since young individuals of approximately this size are occasionally collected, the indication is that this embryo was very near hatching and that the incubation period is about 70 days.—PHILIP C. DUMAS, *Department of Biological Sciences, University of Idaho, Moscow, Idaho.*

STATUS OF THE STRIPED RACER *MASTICOPHIS TAENIATUS TAENIATUS* IN WASHINGTON.—Wright and Wright (1952, Amer. Midl. Nat., 48 (3): 601) considered the occurrence of the striped racer in Washington as problematical. Justifiably, they made no attempt to give specific reasons for listing a particular snake as problematic; however, they gave 12 general reasons for the establishment of their problematic lists.

Slater (1941, Occ. Pap. Dept. Biol. College Puget Sound, 12: 74) reported collecting a specimen of this species of snake in Gingko State Park, a locality west of the Columbia River in Kittitas County. Murray (1942, COPEIA (1): 16) cited Slater's paper and said that "this species may be a rare inhabitant of eastern Washington."

A field trip of the class in herpetology at the University of Washington was made to Vantage Ferry in 1941. Here, on May 3, while collecting on the east side of the Columbia River in Grant County, 5 miles south of Vantage Ferry, one of my students, Harold Gangmark, uncovered a striped racer, *Coluber taeniatus taeniatus*, which was hiding under a dry tumble-weed. This specimen was captured alive and survived in our laboratory for several weeks. It is now preserved in the herpetology collection of the Department of Zoology of the University of Washington. On May 15, 1954, another specimen of the striped racer was collected by the author at Vantage Ferry on the eastern side of the Columbia River. Although it may be rare, this snake is definitely a part of the Washington herpetofauna and occurs on both sides of the Columbia River.—ARTHUR SVIHLA, *Department of Zoology, University of Washington, Seattle, Washington.*

THE STATUS OF THE FOSSIL SNAKE *COLUBER ACUMINATUS*.—Only two species of the genus *Coluber* have been recognized in the fossil record. These are *Coluber acuminatus* (Cope) and *C. constrictor* Linnaeus. The former was described on the basis of a fractured skull and 25 anterior thoracic vertebrae, found in Port Kennedy Cave, Montgomery County, Pennsylvania (Cope, 1899, Proc. Philadelphia Acad. Nat. Sci., 2nd Ser., 11: 197). *Coluber constrictor* has been reported from 2 miles west of Melbourne, Brevard County, Florida, and the Conard Fissure, Willcockson County, Arkansas. All of these localities are of Pleistocene age.

Unfortunately, the type material of *C. acuminatus* was never illustrated and it is now presumed to be lost. However, a comparison of the original

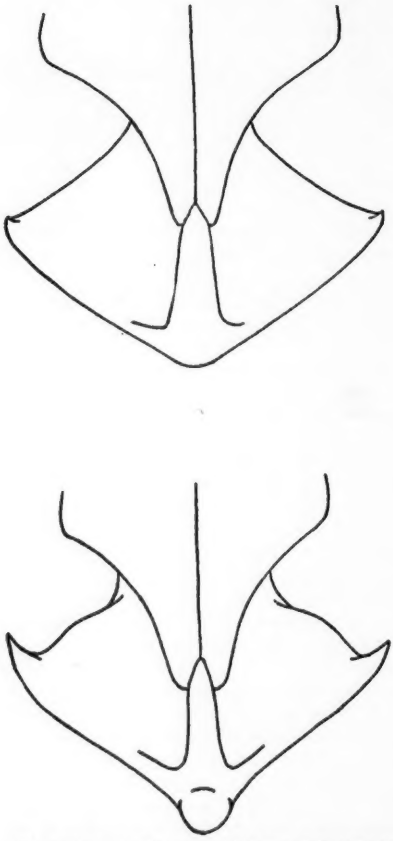


Fig. 1. The shape of the premaxilla in two adults of *Coluber constrictor*. Dorsal view. (To illustrate the premaxilla to best advantage, the septomaxilla is not shown below the nasals.) *Upper:* male, from Oakland Co., Michigan. *Lower:* female, from Gainesville, Alachua Co., Florida.

description with 33 skulls of modern specimens of *C. constrictor* from a few states east of the Rocky Mountains indicates that the characters on which *acuminatus* is based are variable, both individually and ontogenetically. Furthermore, the variation exhibited in the available material includes that given as diagnostic for *acuminatus*, and it seems advisable to relegate this name to the synonomy of *C. constrictor*.

Apparently the premaxillary, maxillary, prootic and mandibular bones were available to Cope, and of these he considered the first three as being distinct from those of *C. constrictor*. *Colubar acuminatus*, on the basis of the number of teeth, is obviously not a member of the genus *Masticophis*.

Of the premaxillary bone Cope stated that "... it is subconic, being narrower and more protuberant than in *Z. constrictor*... an obtusely conical body, the lateral borders enclosing less than a right angle." An examination of this bone in 24 adult and 9 hatchling specimens of *C. constrictor* indicates that the shape is quite variable. When viewed from the side, it is obtuse in all of the hatchlings; in large adults it may be more protruding, frequently acute, and forming a knob-like projection at the anterior end (Fig. 1, lower). The dorsal vertical projection may be slightly convex to straight on the forward edge in adults, but always straight in hatchlings. It may, or may not, extend up beyond the level of contact with the nasals. The lateral wing-like processes may be with (Fig. 1, lower), or without (Fig. 1, upper), a spine-like projection at the tips in either adults or hatchlings. When viewed from above, the angle formed by the anterior edge of this bone varies from 89° to 99°. This observed range in the available material examined indicates that the living species, as well as *acuminatus*, may have this bone so shaped as to be less than a right angle when viewed from above. The two posteriorly directed processes may be in either a horizontal or vertical plane. There are 2 or 3 foramina on the ventral surface, usually 2. The width of the bone divided by the length varies from 1.0 to 1.6 (mean 1.3) in adults, and 1.2 to 2.0 (mean 1.5) in the hatchlings.

Concerning the maxilla Cope stated "... the two internal processes and the space between them measure the bases of eight teeth. In the same space there are nine teeth in a skull of *Zamenis constrictor* with which I compare it." In the specimens that I have examined the distance between the two inner processes (measured from the outer edges of both) contains from 8 to 12 teeth (mean 9.2). As a distance comprising eight teeth is occasionally found in *C. constrictor*, this character is not diagnostic of the fossil species. The foramen on the outer surface is below the 4th to 6th (mean 5.8) maxillary tooth. The outer lateral process is opposite the region between the 11th and 12th maxillary teeth. The posterior part of the bone is flat and lies in a horizontal plane in hatchlings, whereas in adults it is not flat and has considerable thickness. Posteriorly it extends as far as, or slightly farther than, the postorbital.

According to Cope, the inner lamina of the surangular is not as convex in *acuminatus* as in *constrictor*. However, considerable variation is indicated in the specimens that I have examined. The inner lamina is practically straight when viewed from above in all of the hatchlings; in adults it varies from nearly straight to noticeably obtuse (Fig. 2). When viewed from the side, the inner lamina is conspicuously raised above the level of the outer lamina in many of the large adults. This does not

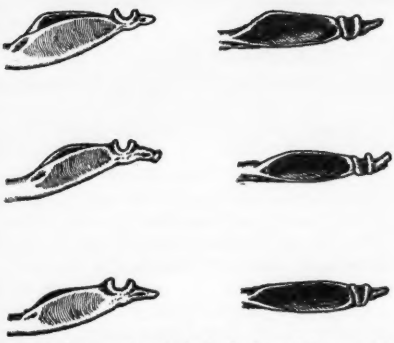


Fig. 2. Ontogenetic variation in the shape of the surangular bone in three females of *Coluber constrictor*. Lateral view (left), dorsal view (right). *Upper:* adult. *Middle:* subadult. *Lower:* hatchling. All from Gainesville, Alachua Co., Florida.

Fig. 3. The shape of the *foramen fasciale* and the bridge between it and the *foramen ovale* in two adult males of *Coluber constrictor* from Gainesville, Alachua Co., Florida.

seem to be true of hatchlings. The height of the inner lamina divided by the distance between the outer surangular foramen and the posterior end of the postarticular varies from 2.5 to 3.3 (mean 2.9) in adults and from 4.3 to 5.1 (mean 4.6) in the hatchlings. The maximum width between the two laminae divided by the maximum height of the inner laminae varies from 2.0 to 1.6 (mean 1.82) in adults and 1.3 to 1.8 (mean 1.5) in the hatchlings. The inner lamina of the surangular may vary from nearly vertical to 45°.

Cope also stated that the cotylus of the quadrate bone in *acuminatus* is wider than in *C. constrictor*. The width of the main portion of the cotylus seems quite constant in specimens of each size group that I have examined. However, a lateral ridge found on the outer and lower surface, forming its lip in this region, is quite variable. A fairly large ridge forms a cotylus which is noticeably wider than when the ridge is weakly developed or absent. Whether or not Cope included this ridge in his description of comparative widths is, of course, impossible to ascertain; it would have been logical to do so, for it constitutes a fairly large portion of the articular surface.

The bridge between the *foramen ovale* and the *foramen fasciale* was mentioned by Cope as being "... narrower than in *Z. constrictor*." He did not state how much narrower, probably because of the difficulties involved in obtaining measurements in this region. In lateral view the bridge may appear wider or narrower due to the shape of the *foramen fasciale* and the angle of its passageway into the cranium. The actual opening into the cranium is not visible in some individuals, especially those of the race *flaviventris*. In others it is clearly evident (Fig. 3).

The bones of the skull have long been utilized in the classification of snakes, especially at the generic or higher levels. However, details of individual, geographic and ontogenetic variation in the cranial elements are still not well known. Although the small number of specimens examined in this study limits the contribution which might have been made toward this end, one fact seems fairly significant: ontogenetic changes in the shape of the cranium of *C. constrictor* are of a greater magnitude than individual or geographic variations. Since the cranial elements are considered relatively important in the classification of snakes and since they are measurably variable, many problems are suggested for further study.—WALTER AUFFENBERG, *Department of Biology, University of Florida, Gainesville, Florida.*

Reviews and Comments

THE SNAKES OF MALAYA. By W. M. F. Tweedie. Government Printing Office, Singapore, 1953: 1–140, 12 pls., 27 text-figs., $5.00 Singapore, about $1.75 American money.—*The Snakes of Malaya* was prepared, as is noted in the foreward, in order to stimulate interest in snakes and to provide a ready means for the identification of local species. In so doing the author, long-time associate and now Director of the Raffles Museum and Library of Singapore, hoped to persuade naturalists in Malaya to obtain additional information, particularly with regard to the life habits, on these animals. This attractive book is thus not only a summary of the scientific knowledge of the snakes of the peninsula but also a popular account meant to appeal to non-scientists as well as biologists. In these respects Tweedie's book may be regarded as the Malaya equivalent of our own Comstock "handbook" series, although superior to them in certain regards.

Quite properly for a book of this type, Tweedie begins with an excellent introductory resumé of the general classification and natural history of serpents, including remarks on incidence and distribution, senses, locomotion, food habits, reproduction, growth, protective coloration and behavior, poisonous snakes and venom, collecting and snake-keeping. This account offers many original observations on Malaya snakes, for local species are emphasized in detailing some of these characteristics. Unfortunately, the coverage of first-aid procedures for snake bite is very weak, although no doubt partially explained by the fact that only five species of Malayan snakes are classed by Tweedie as dangerous to human beings. Nothing is said concerning any method other than the use of antivenin as therapy for snake bite.

The second section of the book presents workable artificial keys to Malayan snakes, followed by descriptions and illustrations of the 127 species known from the peninsula and six forms probably occurring there. In this section each species is adequately, though briefly, discussed with remarks on habits being included wherever possible. Line drawings of the head and other significant features are given for most genera. The major part of the work is followed by a checklist of species, a table indicating general distribution patterns for the Malayan forms found elsewhere in southeast Asia, a basic bibliography of Malayan herpetology, a map of southeast Asia and an index. The general arrangement of families, genera and species follows that in Malcolm Smith's volume on snakes in the *Fauna of British India* (1943) although some names have been changed in the light of recent work. It is regrettable that Tweedie has persisted in retention of older usage of the generic names *Pelamis*, *Ahaetulla* and *Dryophis*, although the rejection of *Pelamis*, at least, dates from early in the century. From the position of a non-resident of the Malayan region it would have been useful if a more thorough discussion of the distributional areas mentioned in the text (for example, Cameron Highlands, Perak, Fraser's Hill) had been given as well as a more extended statement of the range of each species. These are, however, rather minor points of criticism when compared to the overall quality of the book.

In addition to the excellent text-figures *The Snakes of Malaya* is provided with 12 elegant black-and-white photographs of living snakes, each of which occupies a full page, taken by the author. These superb illustrations are certainly among the best snake photographs ever published. The format of the book is very well done with an adequate binding, large legible type and it is printed on good paper. All in all the work is extremely attractive.

Evaluation of the usefulness of this book must be considered from two viewpoints. First, does it satisfy the requirements laid out for it by its author with regard to its value as a popular guide? In so far as I am concerned it does. It appears very likely that anyone seeing or using this book could not fail to become more interested in the subject under discussion. As an identification manual it also qualifies on every count.

The second way in which this publication must be judged is on the basis of its significance as a scientific work. Here again *The Snakes of Malaya* is secure. Dr. Tweedie, who is primarily an ichthyologist but also an ardent field naturalist, has assembled a truly useful summary of our knowledge of the snakes of this region. Although not as detailed as their works, the present book must be considered a great addition to and revision of, the snake sections in the classic papers of Boulenger (1912, *A vertebrate fauna of the Malay Peninsula from the Isthmus of Kra to Singapore, including adjacent islands. Reptilia and Amphibia*), and Malcolm A. Smith (1930, Bull. Raffles Mus., 3: 1–149). Besides adding to our knowledge of variation and distribution of Malayan species, *The Snakes of Malaya* offers numerous data on the habits of these creatures,

although frequently these only indicate lines for future inquiry.

In conclusion, this beautiful little book ought to be in the library of every herpetologist, not only for its value as a systematic summary of the snakes of an important area, but primarily because it represents the highest level of excellence for faunal reports of a popular nature and would serve as a fine model for anyone undertaking a similar project.—JAY M. SAVAGE, *Department of Zoology, Pomona College, Claremont, California.*

A COLORED ATLAS OF SOME VERTEBRATES FROM CEYLON. VOLUME TWO. TETRAPOD REPTILIA. By P. E. P. Deraniyagala, Ceylon National Museums, Colombo, Ceylon, 1953: 1–101, 35 pls. (col.), 10 halftones, 44 text figs. Rs. 15/– (Ceylon Currency), $3.50 (paper).—This new volume prepared by the Director of the National Museums of Ceylon, is the second in a series aimed at eventual illustration (in color) of a majority of the vertebrate fauna of the island. The previous volume contained an illustrated review of Ceylanese fishes, while the present work covers the turtles (eight species), crocodilians (two forms) and lizards (58 species) of this beautiful island. All species of turtles, one crocodile and over half of the lizards are illustrated by color plates prepared by Deraniyagala. Eleven half-tones and numerous line drawings supplement the color plates.

The textual part of the work includes a discussion of the classification adopted, remarks on the general organization of the work, a summary description of the Reptilia and those subdivisions that are found in Ceylon and brief diagnoses and keys to the "tetrapod reptiles" of the island. Of particular interest to herpetologists will be the use of the "type-genus" method of forming suprageneric names (although this procedure is not rigidly followed), description of two new fossil turtles and a new fossil crocodilian, "which might eventually be named "*Crocodylus sinhaleyus*" (p. 4), from the Ratnapura beds (Pliocene), proposal of three new subfamilies of agamid lizards and description of a new genus, two new species and four new subspecies of recent lizards.

The general format, source and nature of illustrative material are subject to the same general criticisms leveled at Deraniyagala's popular publication, *Some Vertebrate Animals of Ceylon* (1949, Nat. Mus. Ceylon, Pictorial Ser: 1: 1–119), by Dowling (COPEIA, 1949 (1): 106), although the quality of paper seems to have been improved. Unfortunately a great many of the illustrations have been previously utilized on numerous occasions by the author and their re-use points up the general lack of uniformity that the book presents. In so far as I know, the colored plates have not been used in any other connection, but although these are printed on relatively good paper they are rather crude reproductions, especially if compared to some of the line drawings elsewhere in the volume. The coloring of the plates is extremely vivid and rivals in gaudiness the covers which are bright scarlet. My experiences with living turtles of some of the figured species suggest that the general coloring in the plates is overdone and sometimes gives an exaggerated, if not erroneous, idea of the life colors of the animals illustrated. The text also suffers from lack of consistency in style and in the amount of space devoted to each group; for example a quarter of the text deals with chelonians (24 pp.) and only about twice that amount with the lizards (53 pp.) To one accustomed to the detailed analyses and descriptions given by modern American workers for new forms, the extremely brief and non-analytical accounts of the new species and subspecies are disappointing.

In spite of these criticisms however, this work together with the review of the snakes of Ceylon (E. H. Taylor, Univ. Kansas Sci. Bull., 33 (2) 14: 519–603) forms a useful and recent survey of the reptilian fauna of this island, supplementing the *Fauna of British India* volumes by Malcolm Smith which lacked extensive distributional data for Ceylon and which are now somewhat outmoded, having been published between 10 and 20 years ago.—JAY M. SAVAGE, *Department of Zoology, Pomona College, Claremont, California.*

FRESHWATER FISHES OF EASTERN CANADA. By W. B. Scott. University of Toronto Press, in Cooperation with the Royal Ontario Museum of Zoology and Palaeontology, 1954: xiv + 128, many text illus., color photo (front cover), map (inside cover page). $2.50.—Although this attractive book is a popular account written largely for the angler and commercial fisherman, students of fishes will find it useful. The coverage includes Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Ontario, where 142 forms of freshwater fishes are known. Anadromous species are included: The arrangement is largely phylogenetic. Most fishes are illustrated by photographs which are diagnostic, except perhaps for the upper three on page 59. A color photograph of the smallmouth bass guarding a nest decorates the front cover. For most species the book gives the distinguishing features, size, occurrence within the area covered, life history and habits, food, and comments including its importance in the fishery. Additions to the known ranges of several species are noted. Keys are absent but the photographs and remarks under diagnostic features will permit proper identification of most of

the important species. The treatment of scientific names is generally conservative.

The lack of adequate documentation is bothersome but expected in a popular work. Much space is wasted by an attempt to keep photographs and pertinent text material on the same page.

Of especial interest to fishery biologists is a foreword by W. J. K. Harkness, giving an outline of the history and present work of the Ontario Department of Lands and Forests.—EDWARD C. RANEY, *Department of Conservation, Cornell University, Ithaca, New York.*

PRINCIPLES OF GENERAL ECOLOGY. By Angus M. Woodbury. Blakiston Co., Inc., New York, 1954: viii + 503, 167 figs. $6.00.—The continuing spread of the belief that the synthetic science of Ecology is of major importance in our modern world is evidenced by the appearance of new textbooks of plant ecology, animal ecology, and of their synthesis into general ecology. Plant ecology and animal ecology, as separate subsciences, are theoretically contradictions in terms. It is likely, however, that they will long maintain an independent existence on account of the need for simplification, by emphasis of one area of thought and investigation at a time, of the enormously complex field. The synthesis in an elementary text is nonethe-less welcome, and a preliminary favorable impression is made by the avoidance of the term bioecology.

The organization of Dr. Woodbury's book is on familiar lines. There are three chapters of general introduction, one devoted mainly to the terminology and definition of concepts, one to the history of ecology, and one to the most general relations of life—to the solar system, the origin of life, and the broadest outlines of the distribution of life in time and space.

The second section is devoted to the physical environment, with chapters on the soil blanket of the earth, water, air, radiant energy, gravity and periodicities, climate, and adaptations that meet the physical environment.

The third part considers biotic interrelationships under the headings biotic communities, development of biotic communities, community analysis, conditions of existence, food relations, reproduction and species persistence, population problems, dispersal and evolution, biotic rhythms and migrations, biotic adaptations, historical distribution, geographic distribution, consortism (for symbiosis), aggregations, societies, and finally ecology and human affairs. There is a bibliography of some 400 titles, and an index of 25 pages.

Turning first to some of the merits and to the more original features, the illustrations include an unusually large proportion of good, of novel, and of timely figures, photographs, diagrams, and maps. Nearly a third of the landscapes and diagrams reflect Dr. Woodbury's wealth of experience in his native Utah, or are otherwise from western North America. His herpetological interests appear in eight of the figures. The treatment of geological history and of the world outlines of the geographic distribution of plants and animals is much more extensive than is usual in ecological texts. There is a corresponding emphasis of maps.

Unhappily, I find much to criticize, especially as to omission of what seems to me to be crucial ecological material. The chapter on the history of ecology is quite inadequate, including much that belongs to the history of biology in general and failing to unravel the ecological threads. The concepts of homeostasis and of the evolution of homeostasis are barely touched upon. Sven Ekman's *Tiergeographie des Meeres* is not cited in the section on the distribution of marine life. Simpson's essays on terrestrial animal geography should be called to the attention of all students. Darwin's volume on the *Formation of Vegetable Mould* makes the best of introductions to Darwin's work and should be called to the attention of beginning students of ecology.

Attentive examination of the bibliography discloses other curious blind spots, and I could not fail to observe that the one reference to a paper by myself is under a title I do not recognize, in an obscure journal. My more properly ecological and zoogeographic papers are not cited. The reference to Hesse, Allee, and Schmidt is to the 1937 edition, and not to the considerably improved second edition of 1951.

A serious criticism of Dr. Woodbury's text is that it is written in obscure and involved and prolix English. The restrictive *that* and the generalizing *which* are used without discrimination; distinguishing the two kinds of clauses that these pronouns should properly introduce is a major step toward clarity and exactness of style. Nouns appear throughout as adjectives, even when the related adjectival form is available and familiar. Worse still is the use of words that do not mean precisely what is obviously intended. And there are too many wholly unnecessary words and phrases and sentences, e.g., "Since ecology is a science, its study involves the use of the scientific approach."—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago 5, Illinois.*

REPORT ON RESEARCH FROM THE ERNEST HOLT INTO THE FISHERY NEAR BEAR ISLAND, 1949 AND 1950. By Michael Graham et al. Ministry of Agr. and Fish., Fish. Inv., ser. 2, vol. 18, no. 3, 1954, London: 1–87, figs. 1–11, pls. 1–4. 12s. 6d. Net.—This, the first report on English fishery research in the Arctic since the

1939–45 war, is authored jointly by six members of the Fisheries Laboratory at Lowestoft. It provides a general account of the cruises, with eight appendices containing details of gear, laboratory equipment, experiments conducted, list of stations, etc. It is intended that other papers on particular subjects will follow (one of which has already appeared). Research was centered mainly on the use of the thermometer as an aid to fishing on Bear Island Bank. Progress from the first two years indicates both favorable and unfavorable results from trying to use thermometers to locate fish. If the cod were not feeding heavily, good catches were made when the bottom temperature was above 1¾°C. Heavily feeding cod were taken in abundance at 0° to −½°C, on grounds east of Bear Island. Generally, during July, August, and September a thermometer was of no use as a fishing aid, except perhaps for haddock on Bear Island Bank. Echo-sounding did not prove valuable in detecting cod. The effects of the Atlantic and the Arctic influences on Bear Island Bank are described. Studies of cod otoliths showed that these could be divided into a number of different types on the basis of structural differences, and tentative conclusions about the concentration of cod are proposed. It is hypothesized that the population constituting the Bear Island cod fishery separates for feeding into two main groups. One migrates to Spitzbergen and the other moves into the cold water toward Hope Island; the return migration usually reconcentrates the two groups at Bear Island from October onward. Marking experiments have since been initiated to test this hypothesis. Studies on the food, mortality and growth of cod, and on plankton, benthos, etc., are also reported.—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

DIRECTORY OF HYDROBIOLOGICAL LABORATORIES AND PERSONNEL IN NORTH AMERICA. Edited by Robert W. Hiatt. Univ. Hawaii Press, Honolulu, 1954: ix + 324 pp., illus. $3.75.—This compact, well-illustrated volume constitutes an up-to-date directory of the facilities and personnel in hydrobiology in North America. The 188 laboratories listed are sufficiently described so that prospective students, as well as established workers, can readily determine the physical establishment and the provisions for research and instruction in hydrobiology in its widest sense. An analysis of the laboratories (103 inland or freshwater, 85 coastal or marine) gives, among other things, comparative data in chart form where research and instruction are available. This is followed by a description of each laboratory and this, in turn, by brief biographical sketches of professional personnel engaged in hydrobiological work. There is a 23-page index of the laboratories. The increased interest in and rapid development of research in aquatic biology during the post-war period fully justify the preparation of this useful work.—ROBERT RUSH MILLER.

CATALOGUE DES TYPES DE LÉZARDS DU MUSÉUM NATIONAL D'HISTOIRE NATURELLE. By Jean Guibé. Colas, Bayeux, France, 1954: 119 pp., $2.00.—Listed are 565 forms, categorized as holotypes, paratypes, syntypes or paratopotypes. This paper-covered book may be bought from the Librairie Thomas, 36 Rue Geoffroy Saint Hilaire, Paris (5), France. The price ($2.00, American) is postpaid.—NORMAN HARTWEG, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

STREAMS, LAKES AND PONDS. By Robert E. Coker. The University of North Carolina Press, Chapel Hill, N. C., 1954: xviii + 327, 28 figs., 25 pls. $6.00.—This is essentially a book on limnology with special emphasis on fish production and factors which influence it. The book is divided into three parts: Pt. I deals generally with the properties of water as a habitat for organisms, considering principally light, heat, gases, stratification and flow, basic nutrients, turbidity, color and odor. Pt. II is concerned with running water—both small streams and rivers—and has a lengthy discussion of pollution. Pt. III covers still waters—ponds and lakes—and the principal types of organisms found in them; the final two chapters (40 pp.) deal with the farm fish pond. Finally there is a 16-page selected bibliography on the subject, and an 11-page index.

It appears that the book was written primarily for the layman, the sportsman and the beginning student. Frequent documented reference is made to the literature. The figures and plate-photos are good; so also was the press work on the book.—GERALD P. COOPER, *Institute for Fisheries Research, University Museums Annex, Ann Arbor, Michigan.*

ZOOLOGICAL RECORD. The Zoological Society of London. Vol. 89, 1952. Sect. 15 (Pisces), July, 1954: pp. 1–94. Price 7*s*. Sect. 16 (Amphibia and Reptilia), April, 1954: pp. 1–139. Price 7*s* 6*d*.—The section on Pisces has 1,115 titles; the section on Amphibia and Reptilia has 1,090. Each section is divided into three parts: I, a list of titles arranged alphabetically by author; II, a subject index, with numerous subdivisions; and III, a systematic index, subdivided by orders and families. Orders for these publications should be sent to the Director, Zoological Society of London, Regent's Park, London, N.W.1, England.

EDITORIAL NOTES AND NEWS

SUMMARY OF 1954 MEETING

THE 34th annual meeting of the ASIH was held in conjunction with the 5th annual convention of the American Institute of Biological Sciences on the Campus of the University of Florida in Gainesville, September 5–8, 1954.

ACTIVITIES OF SEPTEMBER 5

Registration was held in Broward Hall where, during the late afternoon, an AIBS tea was served by the University of Florida faculty wives. ACTING PRESIDENT JOHN S. ALLEN and MRS. ALLEN greeted the delegates.

After lunch a number of members were guests of ROSS ALLEN at the Ross Allen Reptile Institute in Silver Springs, Florida. The tour was arranged by MR. WALTER AUFFENBERG and was attended by approximately 30 members and friends.

After a buffet supper at the Secretary's home, the Board of Governors convened in the Court Room of the Law Building for the annual meeting.

PRESIDENT CHARLES M. BOGERT called the meeting to order at 8:15 PM. Thirty-one governors were present. The reading of the minutes of the 1953 meeting was dispensed with, since they had been published in COPEIA, 1953 (4): 246–53.

The following persons were unanimously elected to fill vacancies in the Board of Governors: Class of 1959: RALPH YERGER, HARRY FREEMAN, KARL LAGLER, HERNDON DOWLING, JOHN D. KILBY, R. H. BACKUS, DAVID JAMESON, ROGER CONANT, A. P. BLAIR and J. SAVAGE. Class of 1957: FRANK CROSS, W. B. SCOTT and ROBERT STORM. Class of 1956: JOSE ALVAREZ. Class of 1955: E. H. TAYLOR and VADIM VLADYKOV.

DR. COOPER discussed the matter of publication dates for COPEIA and inquired as to whether the present dates of publication tied in with the Secretary's operations regarding delinquent members. DR. GROBMAN stated that from the Secretary's standpoint it seemed desirable for COPEIA to come out in February, May, August and November, so that delinquents on the mailing list could receive sufficient warnings and be dropped before COPEIA No. 1 was mailed. DR. COOPER stated that this was satisfactory and that it might be desirable to set the publication date of COPEIA No. 1 as approximately February 10, and subsequent issues every three months thereafter. On motion duly seconded it was unanimously agreed that the plan as described by the Editor and the Secretary be put into effect at the earliest possible date.

DR. COOPER then touched on the matter of postmarks on COPEIA wrappers. PRESIDENT BOGERT inquired if any of those present were materially interested in the dates or postmarks. DR. MILLER said the postmark date was the only way in which the date of publication could be affirmed. PRESIDENT BOGERT asked if this were important in this day and age when everyone was more or less aware of what other people were doing, and he asked whether DR. MILLER was vitally concerned with having postmark dates. DR. MILLER said it was a question of priority in the event circumstances arose in which date of publication was questioned but estimated that this might not arise but once in twenty years. He said that if this would add to the Society's costs he would not want the postmark dates shown. DR. GROBMAN then described the circumstances under which COPEIA is mailed to subscribers, and pointed out that to show the postmark date on all copies mailed out would add materially to the costs—as much as $150.00 or $200.00 a year. DR. COOPER said he had been getting the publication dates by writing to Waverly Press. DR. GROBMAN stated that next year this information could be verified from the postmark. He would arrange to have the Editors' copies sent by parcel post, which would show postmarks. In this way the Editors can verify the publication dates supplied by the publishers.

DR. COOPER then inquired whether or not articles in a language other than English should be included in COPEIA. He said he had contacted the printer and found that the cost of setting type is appreciably more for French or German than for English. DR. MILLER stated that, so far as he knew, only one paper in a foreign language had been submitted recently; it was in French, was received about a month prior to the meeting, and was rejected for other reasons. DR. OLIVER moved that only articles in English be printed and the motion was duly seconded and carried with one dissenting vote.

DR. COOPER discussed the editorial problem of indicating laboratory contribution numbers in footnotes. He said there were some institutions that make a point of keeping track of their contributions and inquired about the responsibility of the ASIH in this matter. PRESIDENT BOGERT stated that he did not feel it was the Society's responsibility to maintain numbering systems for such organizations and asked for the opinion of the governors present He added that he did not feel it added to the

prestige of the Society. After considerable discussion a motion was made by DR. NETTING that, in the future, acknowledgments of support or contribution numbers be embodied in the text of the manuscript, or at the discretion of the author or his institution, be added to the reprint costs at a charge of $5.00 to the institution involved. The motion was tabled.

DR. COOPER raised the question whether the increase in number of vertebrate paleontological papers in COPEIA was excessive. None of the governors expressed concern.

With regard to the publication of an Index to COPEIA, DR. GROBMAN said that during the course of the past year he had had two letters on this subject, one from DR. SUTTKUS and one from DR. CLYDE F. REED of Baltimore, both of whom indicated that independently they had prepared an Index to COPEIA from 1913 to date. After discussion as to the desirability and advisability of publishing an Index to COPEIA, with special reference to content and costs, on motion by DR. CAGLE, duly seconded, it was unanimously agreed that a committee be appointed to investigate the matter of publishing an Index to COPEIA. PRESIDENT BOGERT appointed DR. SUTTKUS a committee of one to carry out this investigation.

Then followed considerable discussion as to whether or not the Society was obligated to distribute reprints containing corrections to the *Herpetological Check List*. DR. NETTING stated that purchasers of the *Check List* had gotten a good useable tool, and that if we started the precedent of giving purchasers, in perpetuity, an annual supplement we would be doing something that no other publisher could afford to do without going broke. PRESIDENT BOGERT said he saw no need for official action on this matter at the present time.

DR. GROBMAN then presented the Secretary's report. He said that the domestic membership fee is $5.00, some of which goes to AIBS, and the Canadian members pay a foreign membership fee of $4.50 but they are still members of AIBS. He recommended that "domestic" hereafter should include both the United States and Canada. After some discussion, agreement was reached, with no formal vote being taken. He then described the present method of billing members for their dues. He stated that if persons are cut off automatically upon failure to pay their membership dues, there are about 80 or 90 drops, which are replaced by the end of the year with about half reinstatements and half new members. DR. GOIN mentioned the additional work involved in reinstating members who have been dropped, and DR. GROBMAN stated that under an arrangement with Waverly Press, the Press holds, for a period of two years, a list of persons who are temporarily suspended; the item cost to the Society is about 10¢. If the members are reinstated, Waverly Press puts them back on the mailing list. DR. GROBMAN added that first statements would be mailed out September 10 (including notices to Canadians who are now to be treated as domestic members); the second notice would go out the middle of October; and the third notice in November. This would still allow time in the new year for the handling of mailing list changes because the first mailing of COPEIA is not scheduled until about February 10. DR. NETTING mentioned the fact that in the depression years, when the Society was smaller, the Secretary knew the problems of the individual members and could handle the matter of membership dues on an individual basis. Many persons appreciated the fact that the Society had carried them for a time, and the Society had not lost much money in the end. DR. GROBMAN said that if a member wrote in saying that he would pay later he was glad to carry him. A number of delinquents are never heard from, and DR. GROBMAN said he thought they were chiefly people who had joined for a year, probably because they had been pressured into it by some zealous professor.

DR. GOIN submitted his report as Treasurer. He added that the Society's present bank balance was $2,844.79, of which about $1,800 would be used in payment of current bills, leaving about $1,000 on hand. The Endowment Fund is now $819. The Revolving Research Fund is now $530.25 instead of $420.25 as shown in the report. This Fund has now reached the point where the early recipients have begun to repay monies advanced and the Society has received $110 this past year. The annual Treasurer's report for 1953 appeared in COPEIA 1954 (4). DR. OLIVER called attention to the item in the Treasurer's report "Received from sale of Check List $97.50." DR. GOIN said his report was on a cash basis rather than on an accrual basis and under the cash basis the only check received in 1953 was for reprints. Other money went to the Publications Secretary who had just given DR. GOIN a check for $1300 for sale of Check Lists, which amount will be credited to the 1954 bank account. This $1300 then goes back into the Endowment Fund.

There was some discussion about the amount for which the Treasurer should be bonded and further discussion as to the necessity or desirability of such bonding. DR. GOIN stated that he had had himself bonded for $1,000, the bonding fee being $5.00, as he considered this was protection for himself. PRESIDENT BOGERT stated that he was not convinced from anything he had heard, or from what he knew of the facts, that it was desirable to have the Treasurer bonded. If DR. GOIN wished to have himself bonded, however, he agreed

that the Society should reimburse DR. GOIN for the bonding fees which he had paid to date and for any subsequent bonding fees.

DR. GREEN reported as Publications Secretary and stated that his 1953 report had been submitted to the Treasurer and was incorporated in the Treasurer's report. He stated that from January 1, 1954, to August 25, 1954, he had received $474.15, and there was $330.52 outstanding, from which he estimated that we will sell about $1,000 worth of back issues this year, which is approximately the same as last year. DR. GREEN reported on the number of back issues on hand and questioned the advisability of reprinting some of the old issues, quoting prices for lithoprinting such material. PRESIDENT BOGERT asked how much a set of COPEIA sold for at the present time. DR. GREEN replied that he had recently charged a company in Switzerland $135 for a complete set of what was in stock. DR. GREEN said he doubted that it was wise to continue reprinting these old issues. If each old number was reprinted as it ran out, there would be an endless job which would involve a considerable sum of money and would be of doubtful value. There was some discussion regarding microfilm cards.

PRESIDENT BOGERT asked DR. GREEN how many copies of the *Check List* had been sold, to which DR. GREEN replied that we had sold 375 bound and 21 unbound copies to June 30, 1954, at a total price of $1386. Expenses in connection with these sales ran to $57.30, making the net income $1328.70 to June 30, 1954, on the sale and distribution of 396 copies. As of September 5, a total of 409 copies have been sold. DR. GREEN said the big sales came the first month but now they are coming in largely from institutions. Forty-five colleges and universities have bought copies.

After a brief recess the Vice-President in Charge of Membership stated he had nothing to report. The Vice-President in Charge of Finance also stated he had nothing to report. DR. INGER, reporting for DR. DAVIS, stated the Committee on the *Check List* had nothing to report.

DR. BAILEY stated, in connection with membership drives, that it had been decided that such drives were unproductive because all they brought in were some neophytes who had been high-pressured into joining the Society and who dropped out at the end of the year. He said, however, that it was sometimes desirable to try to get the newer, younger people in the field interested in joining the Society and he thought it might be well to consider some means of getting such members. DR. OLIVER pointed out that in 1947, 700 mimeographed notices were sent out, and 15 percent responded by joining the Society, but he did not know whether these memberships were just for one year, or whether they continued. DR. GROBMAN suggested that the Society has a nice form letter, based on RANEY's work, that can be sent out to prospective members and that we might try sending these out to see if we could thus get any new memberships. He requested that if any of those present had students, for example, whom they would like to see become members of ASIH, they should advise the Secretary and he would write them with one of the form letters. He mentioned that an article about the origin and growth of the ASIH had appeared in *Science*, following ASIH's affiliation with AAAS, and that as a result only three persons had written in asking to join the Society.

DR. INGER submitted the report of the committee to study the distribution of responsibilities among the officers of ASIH. PRESIDENT BOGERT commented on the main points in the report and DR. OLIVER then asked for the reactions of the present Treasurer and the present Secretary, since the report was chiefly concerned with the distribution of responsibilities between those two officers. DR. GOIN said that it was his feeling that the ASIH is now running on a very businesslike basis, due largely to the help the present officers have had from past officers of the Society. One of the points he stressed was that the person who handles the actual cash should not do any of the bookkeeping in connection with the finances and that this was the way the matter was now being handled, with DR. GROBMAN receiving the money for membership dues, etc., and turning it over to DR. GOIN who did the necessary book work. MR. MEADE stated it was considered good business practice to separate the work of the Secretary from the work of the Treasurer. DR. INGER said that the Treasurer should receive the dues and other monies and that the Secretary should direct the operations of the headquarters office, keep the minutes, etc. MR. MEADE said that in most societies the bills are sent out and the money received by the Treasurer. DR. RANEY said that the load of the Secretary should be lightened and one of the ways to do this would be to take the billing and collections out of his hands. PRESIDENT BOGERT brought up the question of the responsibility of the Secretary to attend AIBS meetings and DR. GROBMAN said that he enjoyed going to Washington once a year. DR. BOGERT stated that the Secretary was the logical person to attend these meetings as he was closest to the membership and to the workings of the Society in general. DR. GROBMAN pointed out the desirability of having one person attend these AIBS-NRC meetings for several years in succession because the meetings were complex and, until one had attended a couple of them, much of the significance of what transpired was lost. In connection with the work of the Secretary, DR. GROBMAN re-emphasized that the

biggest problem concerns the billing and collection of dues. He said that when the Society dealt with Ann Arbor Press the job was very heavy but it has been much simplified since we have been operating with Waverly Press. He described the manner of handling mailing lists through the use of addressograph plates. He suggested that if he and DR. GOIN were re-elected for another year, procedures should be continued as at present. PRESIDENT BOGERT said the problem would be to find someone to take over the Secretary's job because it was of sufficient importance that very few people could have the time for it. DR. SCHMIDT moved that action on the report of this committee be tabled; the motion was seconded and unanimously carried.

PRESIDENT BOGERT asked the Secretary for his report on the AIBS meeting. DR. GROBMAN explained that AIBS is a federation of biological societies and that ASIH was meeting in Gainesville this year under its auspices. The only important business he wished to bring up was the following: AIBS has been under the guidance of the National Research Council which charges AIBS 15 percent of all contracts as overhead expense for the use of office space in Washington. AIBS was to hold a Governing Board meeting in Gainesville tomorrow and DR. GROBMAN thought the consensus of the meeting would be that AIBS should divorce itself from the National Research Council and operate independently. DR. GOIN asked DR. GROBMAN for his opinion on the subject and DR. GROBMAN responded that he thought it would be a good move. DR. RANEY said that when AIBS was first set up, the NRC carried it for a while. DR. GROBMAN said that AIBS had been operating under a grant of $50,000 from the Rockefeller Foundation which had now expired. Hence, AIBS was in tight financial straits and if it could move out of NRC's headquarters into cheaper space it would be on a sounder financial basis. The Governors voted in favor of the separation.

On motion duly made, seconded and unanimously carried it was agreed that the ASIH contribute forty pounds Sterling to the support of the Zoological Record, as it had done in previous years.

PRESIDENT BOGERT said that last year the Society was invited by DR. FOLLETT to hold its annual meeting at the California Academy of Sciences. DR. FOLLETT discussed the advantages and disadvantages of such a meeting. PRESIDENT BOGERT then appointed DRS. FOLLETT, STEBBINS and BLAIR a committee to consider the details for next year's meeting. DR. FOLLETT was to act as chairman of the committee and it was to report at the Business Meeting of the ASIH on Wednesday, September 8.

DR. PETERS reported on a method for bringing the *Systema Naturae* up to date. There was prolonged discussion as to costs, etc. There was some explanation by DR. PETERS as to what was involved in this project and considerable objection was raised on the ground that the plan was impracticable. DR. INGER moved that the Society not proceed with the project. The motion was duly seconded and approved, with one dissenting vote.

PRESIDENT BOGERT stated that he would appoint DR. MYRON H. HALPERN of Hahnemann Medical College, Philadelphia, as the Society's representative at the International Congress on Anatomy to be held in Paris in 1955.

DR. GROBMAN brought up the subject of import duty on glass jars and read correspondence received from the Administrative Assistant to CONGRESSMAN BILLY MATTHEWS regarding legislation covering the import duty on these jars. Final action easing import restrictions will not occur until the new Congress convenes.

DR. JAMES PETERS asked whether the Society would be willing to sell a complete of COPEIA at half price for an institution at Sao Paulo, Brazil. The set would be purchased with funds contributed by members of the Society and presented to the institution. It was not felt that this matter required action by the Board of Governors and it was informally agreed that DR. GREEN be permitted to make the sale of one set of COPEIA at half price under the conditions stipulated above.

The meeting adjourned at 11:30 PM.

ACTIVITIES OF SEPTEMBER 6

The first formal session was convened at 9:00 AM by PRESIDENT BOGERT, in the Science Reading Room of the University Library. The following papers were presented to over 150 members and guests:

Factors affecting gene exchange between Pseudacris nigrita and Pseudacris clarki.—Hague L. Lindsay, Jr., University of Texas.

Life history of a goby, Bathygobius soporator.—William N. Tavolga and Robert W. Neelands, College of the City of New York.

Productivity versus environmental resistance in the rusty lizard, Sceloporus olivaceus.—W. Frank Blair, University of Texas.

An evolutionary study of island faunas in the Gulf of California, Mexico, with a method for comparative analysis.—C. H. Lowe, University of Arizona.

The need for a yardstick in specifying lower categories in systematic ichthyology.—Ernest A. Lachner, U. S. National Museum.

Notes on the genus Calamaria.—Robert F. Inger and Hymen Marx, Chicago Natural History Museum.

Concurrently, demonstration papers were being presented in Science Hall. A single such demonstration was made by an ASIH member:

Effects of different X-ray dosages on development in the Mexican toad, Bufo valliceps.—W. Frank Blair, University of Texas.

After lunch further papers, as follows, were presented in two concurrent sections. In the Ichthyological Section, presided over by REEVE M. BAILEY, the following papers were presented:

Fishes of the family Amblyopsidae.—L. P. Woods and R. F. Inger, Chicago Natural History Museum.

North-south differentiation of blenid fishes in the Central Pacific.—Donald W. Strasburg, Duke University.

Some aspects of the early life history of the Hawaiian surgeon fish, Acanthurus triostegus.—Jack Randall, University of Hawaii.

Problems arising in revision of Hubbs and Laglers "Fishes of the Great Lakes Region."—Karl F. Lagler and Carl L. Hubbs, University of Michigan, and Scripps Institution of Oceanography.

Description of the lateral line system of the pirate perch, Aphredoderus sayanus.—George A. Moore and William E. Burris, Oklahoma A. & M.

Subspecies of the rock bass, Ambloplites rupestris.—E. E. Deubler, Jr. and Edward C. Raney, Cornell University.

The fishes of Davis Bayou, Ocean Springs, Mississippi.—Hurst H. Shoemaker, Gulf Coast Research Laboratory, Ocean Springs, Miss.

Population studies in South Carolina reservoirs.—Jefferson C. Fuller and Harry W. Freeman.

In the Herpetological section, presided over by GEORGE P. MEADE, the following papers were presented:

Mexican-eastern United States biotic affinity from a herpetological viewpoint.—Paul Martin, University of Michigan.

Sperm storage in snakes.—Wade Fox, School of Medicine, Louisiana State University.

A study of the Florida sand skink, Neoseps reynoldsi Stejneger.—Sam R. Telford, University of Virginia.

Color phases in Plethodon c. cinereus.—Gordon R. Thurow, Bloomington, Indiana.

The midland water snake, Natrix sipedon pleuralis, in eastern Tennessee.—Richard Johnson, Tennessee Wesleyan College.

Certain aspects of the cranial morphology of Bufo woodhousei woodhousei and Bufo valliceps.—Richard J. Baldauf, Texas A. & M. College.

Broods and food of Natrix septemvittata Say in North Carolina.—E. E. Brown, Davidson College.

Some aspects of the biological relationships of the southeastern subspecies of Pseudemys floridana.—John W. Crenshaw, University of Florida.

Amphibia and Reptila of the Savannah River Operations Area, South Carolina.—Harry W. Freeman, University of South Carolina.

In the evening there was a general meeting for all participating societies in the Florida Gymnasium. About 2,000 persons attended. DR. H. BENTLEY GLASS, Chairman of the Governing Board of AIBS presided. He introduced DR. JOHN S. ALLEN, Acting President of the University, who welcomed the delegates. DR. GROBMAN then introduced DR. ARCHIE F. CARR of the University of Florida, whose address was entitled "The Passing of the Fleet." It was a matter of considerable prestige for the Society to have one of its members participate as the main speaker and give such an excellent presentation.

ACTIVITIES OF SEPTEMBER 7

At 9:30 AM there was a joint meeting with the Society for the Study of Evolution and the Society of Systematic Zoology, in the Law Building. A symposium, "The Origin and Evolution of the Biota of Florida," was presided over by DR. KARL P. SCHMIDT. The speakers were: A. S. ROMER, Harvard University, "Fossil History." R. A. HOWARD, Harvard University, "Recent Flora." T. H. HUBBELL, University of Michigan, "Recent Fauna." The symposium was very successful and was attended by more than 300 persons.

During the afternoon there were two concurrent sections. The section on Ichthyology, presided over by DR. GERALD P. COOPER, heard the following papers:

Spermatogenesis in a Maryland brook lamprey, Lampetra aepyptera.—Herbert F. Seversmith, Bethesda, Maryland.

The morphological relationships between the swim bladder and ear of the Holocentridae.—Edward M. Nelson, Stritch School of Medicine, Loyola University, Chicago.

Fishes of the Campeche Banks and their relationship to fishes of other parts of the Gulf of Mexico.—L. P. Woods, Chicago Natural History Museum.

The embryo of the angel shark, Squatina dumeril (LeSueur), and natural history notes on the species in North Carolina waters.—William E. Fahy, University of North Carolina, Institute of Fisheries Research.

Breeding and sexual dimorphism in Cyprinodon variegatus on the Louisiana coast.—George K. Reid, Jr., Texas A. & M. College.

A new percid fish (Hadropterus) from Oklahoma and Arkansis.—George A. Moore and Jones D. Reeves, Oklahoma A. & M. College.

The effect of light and temperature on the reproductive rate of the green throat darter, Etheostoma lepidum.—Clark Hubbs, University of Texas.

The following papers were presented before the section on Herpetology which was presided over by DR. N. BAYARD GREEN:

Clinal variation in the racers, Coluber, of North America.—Walter Auffenberg, University of Florida.

Dynamics of a natural population of the cricket frog, Acris gryllus crepitans.—William F. Pyburn, University of Texas.

Variation and relative growth in plastral scutes of the turtle, Kinosternon integrum LeConte.—James F. Mosimann, University of Michigan.

Ecological distribution of amphibians and reptiles in southern Florida.—William E. Duellman, University of Michigan.

The toxicity of Scaphiopus hurteri venom in mice.—David Pettus, University of Texas.

A study of variation in the short-tailed snake, Stilosoma extenuatum.—Richard Highton, University of Florida.

Ecological factors affecting the genetic structure of natural populations in Amphibia.—David L. Jameson, University of Oregon.

The status of two southwestern skinks, Eumeces gaigei and Eumeces taylori.—John S. Mecham, University of Texas.

At 6:30 PM about 130 members and guests assembled for the annual banquet at The Gainesville Golf and Country Club. The ASIH members were

privileged to use the Country Club facilities through the courtesy of COLONEL and MRS. WILLIAM HUNTER of Gainesville. ACTING PRESIDENT ALLEN of the University of Florida, and MRS. ALLEN were guests of the ASIH at the banquet. DR. NORMAN HARTWEG, who served as toastmaster, was awarded the Gold Star of the ASIH by PRESIDENT BOGERT for meritorious service in connection with his editorial duties. The address of the retiring president, CHARLES M. BOGERT, American Museum of Natural History, was entitled "Amphibian Calls and Their Significance." PRESIDENT BOGERT not only played recordings of the calls but also synchronously showed kodachromes of the animals involved. His talk, the slides, and the recordings were excellent and the address as a whole was most stimulating and informative.

After the banquet, many members attended the Open House being held at the Florida State Museum, in company with delegates from other AIBS societies. The chief feature of herpetological interest at the Museum was the exhibit of the crocodilians of Florida. Although the recently discovered Pliocene Gavial was featured, the skulls of all known Florida forms, fossil and recent, were on display.

ACTIVITIES OF SEPTEMBER 8

At 9:00 AM concurrent sections were again held. DR. ROBERT R. MILLER presided over the Ichthyological section, during which the following papers were presented:

Fishes from the Escambia River, Alabama and Florida, with ecologic and taxonomic notes.—Reeve M. Bailey, Howard E. Winn and C. Lavett Smith, University of Michigan.

Hybridization of Texas darters.—Clark Hubbs and Kirk Strawn, University of Texas.

A plea for a broader base in systematic ichthyology.—William Gosline, University of Hawaii.

Mortality rate of eggs and larvae of Etheostoma lepidum.—Kirk Strawn, University of Texas.

Status of the Carolina race of striped bass, Roccus saxatilis.—William S. Woolcott and E. C. Raney, Cornell University.

Speciation in the Middle American fishes of the genus Profundulus.—R. R. Miller, University of Michigan.

A new sturgeon from the Gulf of Mexico.—V. D. Vladykov, Canadian Department of Fisheries, Quebec.

Taxonomic position of the non-parasitic lampreys of the genus Lampetra from western North America.—V. D. Vladykov, Canadian Department of Fisheries, Quebec.

The Herpetological section, with DR. NORMAN HARTWEG presiding, heard the following papers:

Metachrosis in snakes.—Wilfred T. Neill, Ross Allen Reptile Institute.

The nine herpetofaunal sections of Nova Scotia.—Sherman Bleakney, National Museum of Canada, Ottawa.

The annual activity cycle of Taricha torosa.—William Riemer, Museum of Vertebrate Zoology, University of California, Berkeley.

The Coraco-radialis Proprius of Ambystoma maculatum.—James M. Moulton, Bowdoin College.

Notes on the Sternotherus carinatus complex with a description of a new form.—Donald W. Tinkle and Robert G. Webb, Tulane University.

Some aspects of ecology and distribution in Rana boylei and its relatives.—Richard G. Zweifel, University of California, Berkeley.

The iguanid genera, Urosaurus and Uta, with remarks on related groups.—Jay Savage, Stanford University.

The elements of systematics and zoogeography in two species of the lizard genus, Holbrookia.—Ralph W. Axtel, University of Texas.

At noon, members assembled on the steps of the Administration Building for the annual photograph. Copies may be ordered from RICHARD HIGHTON, Department of Biology, University of Florida, for 62¢.

During the afternoon there was a single joint section with DR. COLEMAN J. GOIN presiding. The following papers were presented:

A study of natural pickerel hybrids: Esox niger × Esox americanus americanus.—Edward C. Raney, Cornell University.

Factors affecting interbreeding of allopatric and sympatric populations of spadefoot toads (genus Scaphiopus).—Aaron Wasserman, University of Texas.

Evolution of behavior in the darters (Pisces-Percidae).—Howard E. Winn, Lerner Marine Laboratory, Miami.

Observations on the reproductive habits of the tadpole-carrying frog, Phyllobates subpunctatus.—Robert C. Stebbins, University of California.

Growth and sexual maturity in some common reptiles.—Henry S. Fitch, University of Kansas.

Following the presentation of papers, the Society's business meeting was held at 4:30 PM in the Science Reading Room of the University Library, with PRESIDENT CHARLES M. BOGERT in the chair. PRESIDENT BOGERT called on the Secretary to read the minutes of the meeting of the Board of Governors of the Society held on Sunday, September 5. After they were read, PRESIDENT BOGERT stated that the Secretary had been serving as the Society's representative on the AIBS Governing Board and that some action was required at the ASIH business meeting in connection with activities of AIBS. The ASIH is a charter member of the AIBS. He asked DR. GROBMAN to present the matter to the meeting.

DR. GROBMAN stated that for the last four years AIBS had been enjoying a grant from the Rockefeller Foundation which provided AIBS with $12,500 a year in additional funds upon which to draw for its operations. He stated that AIBS had been operating under the aegis of the National Research Council, using NRC headquarters in Washington, and in return had been giving 15 percent of its contractual income to NRC as overhead. With the completion of the Rockefeller Foundation Grant, AIBS now finds itself with an annual deficit of about $9,000. One way to reduce this would be for AIBS to move out of NRC's comfortable quarters and move into quarters more

fitting to its present income. It could then use the 15 percent for its own overhead and it is felt that it could then reduce its annual deficit most markedly. DR. GROBMAN said that there was considerable discussion in Washington last April regarding this and since the April meeting the Executive Committee of AIBS had met in New York and had decided to separate from the NRC and to operate independently in continuing its work. This action by the Executive Committee was unanimous. The Governing Board of the AIBS met in Gainesville on September 6 and again discussed the matter fully and unanimously voted to disassociate AIBS from the NRC and move into separate quarters. DR. GROBMAN stated that it was now required that the ASIH vote on this matter, since AIBS requires two kinds of confirmation; i.e., by its Governing Board, which it already has, and approval of three-fifths of the member societies. The Secretary then moved that ASIH favor the recommendation of the Governing Board of AIBS to disassociate AIBS from the NRC. The motion was seconded by DR. NETTING and unanimously carried.

The Chairman of the Stoye Prize Committee, DR. HERNDON DOWLING, then announced the recipients of the awards for this annual meeting. The Stoye prize in Ichthyology was awarded to JACK RANDALL of the University of Hawaii for his paper "Some Aspects of the Early Life History of the Hawaiian Surgeon Fish, *Acanthurus triostegus*." Two co-first prizes were awarded for papers in Herpetology, one to JOHN W. CRENSHAW, University of Florida, for his paper, "Some Aspects of the Biological Relationship of the Southeastern Subspecies of *Pseudemys floridana*," and the other to WALTER AUFFENBERG, also of the University of Florida, for his paper, "Clinal Variation in the Racers, *Coluber*, of North America."

DR. FOLLETT, Chairman of the Committee on Zoological Nomenclature, submitted the following report:

During the past year, the Society's Committee on Zoological Nomenclature has consisted of FRED R. CAGLE, ROBERT RUSH MILLER, HOBART M. SMITH, ROBERT C. STEBBINS, NORMAN J. WILIMOVSKY and W. I. FOLLETT, Chairman.

Activities of the Committee have been concerned primarily with the Fourteenth International Congress of Zoology, Copenhagen, 1953, and its nomenclatorial decisions.

The chairman, in company with PROFESSOR CARL L. HUBBS, participated in all sessions of the Colloquium on Zoological Nomenclature (which continued for seven days before the opening of the Congress), as well as the sessions of the Section on Nomenclature, the joint sessions of the International Commission on Zoological Nomenclature, and the final Concilium Plenum of the Congress. These meetings were held from July 29 through August 12, 1953, at the University of Copenhagen. DR. KARL P. SCHMIDT, the Society's official representative, attended meetings of the Colloquium and presided, with manifest skill, over the sessions of the Section on Nomenclature.

Numerous problems of nomenclatorial practice were considered at these meetings.

It was expressly agreed that a primary purpose of the Rules is the establishment of stability and universality in nomenclature; that brevity and clarity are urgent desiderata; that the maintenance of uniform Rules throughout zoological nomenclature is important; and that modification of a former trend away from automatic nomenclature is to be favored.

New terminological provisions include the adoption of the expression "taxon" (plural, "taxa") to denote a taxonomic unit of any rank; the expression "binomen" for the binominal combination of generic and specific names, and "trinomen" for the trinominal combination of generic, specific, and subspecific names; the restoration of the expression "specific name" to the name that distinguishes a species from all others of its genus; and the substitution of the expression "nominate" for the expression "nomino-typical" to signify the subgenus that includes the type species of its genus, and the subspecies that is based on the same type specimen as its species.

Other decisions included the recognition of a principle of conservation (sometimes called "prescription") to avoid the replacement of a name in current use by a long-unnoticed senior synonym; the recognition of neotypes as a category of type specimen; the augmentation of provisions regarding the family group of categories; the proposed adoption of rules for the naming of orders and higher categories; the adoption of rules for the emendation of generic and specific names, and for determination of the gender of generic names; the abolition of all diacritic marks in the writing of zoological names, and the proposed adoption of a schedule of equivalent letters to be substituted for those that originally bore diacritic marks; and the reinstatement of the rule of the first reviser in place of the rule of position precedence (sometimes loosely referred to as "line priority.")

A new principle will permit an author to publish a notice in the *Bulletin of Zoological Nomenclature*, proposing a certain action (such as the suppression of a name), on grounds fully stated in that notice. Upon such publication, the proposed action is to become provisionally effective, but is to remain subject to challenge for a period of time specified in that notice (for example, two years.) If no challenge is lodged with the Commission's Secretary during the specified period, the action is to become

fully effective. If such challenge is lodged within the specified period, the case is automatically referred to the International Commission for decision. Among the problems to which this principle will apply are departure from priority in the naming of a category formed by the union of two taxa of the Order/Class group, or in the naming of a family; the retention of an emendation in general use but not valid under the revised Rules; the designation of a neotype; the validation of a neotype established before the enactment of the Rules regarding neotypes; the suppression of a *nomen dubium*; and the replacement of a junior secondary homonym.

The revised Rules are to be drafted by PROFESSOR J. CHESTER BRADLEY, of Cornell University, President of the International Commission on Zoological Nomenclature. As so drafted, the revised Rules are to be published in the *Bulletin of Zoological Nomenclature*, after which a specified interval, not less than six months, will be allowed for comments by zoologists in general. Thereafter the International Commission will take action on all matters arising from the comments submitted, and will finally approve the text of the revised Rules, which will then be published. Both the English and the French versions of the revised Rules will constitute official texts. In the event of any question as to a discrepancy between them, the problem is to be referred to the International Commission.

These decisions are fully reported in a book entitled *"Copenhagen Decisions on Zoological Nomenclature,"* which may be purchased for 75¢ postpaid from the International Trust, 41 Queen's Gate, London, S.W. 7.

In order to assist the Society's Committee on Zoological Nomenclature to prepare in advance for a consideration of the problems that will arise upon publication of PROFESSOR BRADLEY'S draft, the Chairman prepared in manuscript form an abridged version of the 1953 Copenhagen decisions, comparable to that which he issued last year, in unpublished form, in connection with the 1948 Paris enactments. When this manuscript was nearly ready for final typing, the suggestion was tendered that it would be more useful to combine with it a restatement of the former Rules that remain in effect, together with those of the 1948 Paris enactments that are to be retained, in order that the manuscript might present as nearly as possible a preview of the revised Rules. This combined restatement of the former Rules, the 1948 Paris enactments, and the 1953 Copenhagen decisions is now approximately two-thirds finished, and will be multilithed and sent to the members of the committee as soon as possible.—Respectfully submitted, W. I. FOLLETT, Chairman, ASIH Committee on Zoological Nomenclature. Dated: August 31, 1954.

DR. SUTTKUS, as Chairman of the Resolutions Committee, presented the following Resolution, which was adopted:

Whereas, the thirty-fourth annual meeting of the American Society of Ichthyologists and Herpetologists, held at the University of Florida at Gainesville, Florida, from September 5 through September 8, 1954, has been successfully completed:

Therefore, be it resolved:

That the members of the Society express their sincere thanks and appreciation for the unlimited courtesy and hospitality extended to them by the local committee: ARCHIE F. CARR (Chairman), DUKE WILDER, FRED BERRY, and their assistants.

That ARNOLD B. GROBMAN, Chairman of the Local Committee for AIBS, officers of the AIBS and JOHN KILBY be wholeheartedly thanked for their success in arranging a splendid program.

That we extend special thanks to JOHN KILBY for his outstanding job in working with DR. CARR to arrange the banquet, and that we extend appreciation to COLONEL and MRS. HUNTER for serving as host at the Gainesville Golf and Country Club.

Furthermore, be it resolved:

That we extend our appreciation to ARNOLD B. GROBMAN, Director of the Florida State Museum, for the open house reception.

That we give our sincere thanks to JOHN S. ALLEN, Acting President of the University of Florida, for the facilities and hearty cooperation extended to the Society.

That we are indebted to WALTER AUFFENBERG for his fine job in arrangement of transportation for field trips.

That we thank ROSS ALLEN for courtesies extended to the members of the Society at the Ross Allen Reptile Institute.

Finally, be it resolved:

That ARNOLD and HULDA GROBMAN be thanked for their hospitality extended to the members of the Board of Governors at their home.

DR. SUTTKUS, who had been appointed a committee of one to confer with DR. CLYDE F. REED of Baltimore regarding the Index to COPEIA, reported that DR. REED had done a much more complete job than he, SUTTKUS, had done. He stated that he and DR. REED had duplicated their efforts in an author index. DR. SUTTKUS stated that DR. REED had progressed about two-thirds of the way through all the numbers of COPEIA, with a geographical index, a taxonomic index, and a subject index. His author index is in manuscript form and consists of 220 pages of double-spaced typing and DR. REED estimates there will be at least half again as many pages for the rest of the indices. DR. SUTTKUS stated he felt that DR. REED'S method was quite complete and would make a satisfactory index.

The author index contains the page number, year, and in the taxonomic index he has listed the title of the article, and whether there are figures, plates or maps. In the early numbers, in the old series, DR. SUTTKUS stated that there is a good deal of confusion since some of the pages were not numbered and suggested that something will have to be worked out to take care of this. DR. SUTTKUS inquired whether the Society was interested in continuing the study of an index, and whether the Society would publish it. He raised the further question as to the higher categories, beyond genera, species and subspecies. DR. REED, he stated, did not include those higher categories. DR. SUTTKUS said he planned to go over a copy of DR. REED'S manuscript and check it with his own index, which is on cards. He asked whether the members felt that there should be one index for ichthyological papers and another index for herpetological papers, and whether or not the higher categories should be included. The matter of categories, it was unanimously agreed, should be left to the indexers and after some discussion it was voted to have one index instead of two.

DR. NETTING brought up the matter of sales of the *Herpetological Check List* and asked if any advertising had been done to promote sales. He said that we were concerned with the matter of an index to COPEIA, but that based on the sales of the *Check List* it was questionable whether it would be profitable for the Society to have the index prepared. He urged that efforts be made to increase the sales of the *Check List*. It was decided that some advertising should be undertaken.

PRESIDENT BOGERT turned the meeting over to the Chairman of the Nominating Committee, DR. W. FRANK BLAIR. Two or three persons were nominated for several of the offices. The following were elected for annual terms beginning January, 1955:

President—EDWARD C. RANEY
Vice-presidents:
Conservation—ROBERT C. STEBBINS
Finance—L. M. KLAUBER
Membership—ERNEST A. LACHNER
Treasurer—COLEMAN J. GOIN
Secretary—ARNOLD B. GROBMAN
Publications Secretary—N. BAYARD GREEN
Editors—GERALD P. COOPER, ROBERT R. MILLER, NORMAN HARTWEG
Editoral Board—FRED R. CAGLE, WILLIAM A. GOSLINE, EARL S. HERALD, ERNEST A. LACHNER, R. C. STEBBINS

During the tallying of the ballots, there was discussion as to the time and place of future meetings. DR. FOLLETT said that at this time the Committee felt that the next meeting would probably be the last week in June, 1955, at the California Academy of Sciences, San Francisco. DR. GROBMAN said that he thought it desirable to meet in some years with AIBS. Future AIBS meetings are scheduled for 1955 at Michigan State, 1956 at the University of Connecticut, 1957 at Stanford, and 1958 at Indiana University.

DR. RANEY said that he was pleased to accept the Presidency of the Society and MR. BOGERT stated that, as Retiring President, he would like to make the statement that it had been a pleasure to work with the officers of the Society and he felt that the incoming new officers would have their full support as he had had. MR. BOGERT also commented on the wealth of excellent hand books available for herpetologists and contrasted this with what was available when he first became interested in the field. He made the point that the very high quality of student papers may be largely attributed to this literature. He concluded his remarks by mentioning new books that he knew were in preparation.

The meeting adjourned at 5:45 PM.

During the evening a Biologists' Smoker was held, under AIBS auspices, in Broward Hall. Members were able to visit the exhibits installed by many commercial concerns and University departments. The Committee on Herpetological Common Names stayed over in Gainesville on September 9 to complete its deliberations.

The meetings seemed to be among the most successful the Society has ever held. More papers (61 and a symposium) were presented than at any previous meeting. The attendance was even greater than at last year's New York meeting. In addition, many ASIH members were pleased to have the opportunity to hear papers presented before cognate societies, also convening under AIBS auspices, on the University of Florida Campus during the same four-day period.—ARNOLD B. GROBMAN, *Secretary*.

Western Division meeting, 1954

THE 23rd annual meeting of the Western Division of ASIH was held on June 24-25, 1954, at the State College of Washington, Pullman, Washington, as part of the annual meeting of the Pacific Division of AAAS. There were two half-days of symposia held jointly with the Society of Systematic Zoology, one on "The use and value of meristic characters in fish systematics and fish population studies" and one on "Current practices in the use of the subspecies concept"; a half-day of submitted papers in ichthyology; and a half-day with a symposium on "Amphibian ecology" and submitted papers in herpetology.

There were two second prize awards in ichthy-

ology: one to GEORGE C. WILLIAMS, University of California, Los Angeles, for a paper on "Differential vertical distribution of the sexes in the clinid fish *Gibbonsia elegans*"; and one to RICHARD H. ROSENBLATT, University of California, Los Angeles, for a paper on "The fishes of the genus *Zanclus* in the eastern tropical Pacific."

There was one first prize award in herpetology to BAYARD H. BRATTSTROM, University of California, Los Angeles, for a paper on "Recent studies on Cenozoic reptiles and amphibians and their climatological significance."

New officers were elected as follows: *President*—BOYD W. WALKER, Department of Zoology, University of California, Los Angeles; *Vice-President*—BAYARD H. BRATTSTROM, Department of Zoology, University of California, Los Angeles; and *Secretary-Treasurer*—ANITA E. DAUGHERTY, California State Fisheries Laboratory, Terminal Island.

The invitation to the national society to meet on the Pacific coast in 1955 was renewed.—ANITA E. DAUGHERTY, *Secretary-Treasurer, Western Division.*

Philadelphia Academy

RENOVATION and reorganization of the herpetological collections of the Academy of Natural Sciences of Philadelphia are now complete. The entire collection has been moved from its previous unsatisfactory quarters to a new dust-proof collection room. The new room is provided with adequate lighting and modern steel shelving. The approximately 20,000 alcoholic specimens have been completely re-alcoholed and most of the old bottles have been replaced with new, more adequate containers. Dried specimens have been placed in clearly labeled cartons and located together in the new collection.

The herpetological specimens have been arranged in a new group-number system patterned after the systems adopted in the major ichthyological collections in this country. The specimens have been arranged alphabetically within each group by genus, species and subspecies. The system contains 50 groups for the arrangement of amphibians and reptiles. New printed labels bearing the group number, catalog number, species name and locality data have been placed in about 40 percent of the containers. It is hoped that these labels will gradually replace the various inadequate labels utilized in the past.

The Philadelphia collections contain the primary types (holotypes, syntypes and lectotypes) of approximately 400 amphibian and reptilian names. Paratypes of about 200 nominal species are also in the collection. The primary types have been sorted out, relabeled with new printed labels, given new alcohol and placed in a separate section of the collection room. All bottles containing primary types have been clearly marked with red ribbon or tape so that they can be easily identified if mislaid. It is hoped that eventually a fire-proof room may be constructed for the type specimens.

Due to the fact that the Academy's herpetological collection is the oldest in the nation, almost all the type material of such early workers as JACOB GREEN, RICHARD HARLAN, JOHN E. HOLBROOK, EDWARD HALLOWELL and the LECONTES are in the collections. In addition, a considerable number of types of names proposed by ROBERT KENNICOTT, CHARLES GIRARD, and EDWARD D. COPE are also housed in the Academy. Since COPE's day, the collections have been enriched by type material from ARTHUR E. BROWN, EMMETT R. DUNN and ROGER CONANT, among others.

The office-laboratory of the herpetological division has been completely remodeled. The room is now equipped with modern lighting, a new tile floor, new steel shelving for books and specimens, new office furniture and storage cabinets, and fine new alcohol- and formalin-resistant work table and sink. This office-laboratory is to serve the needs of the division and provides ample space for visiting scientists to carry on their work under excellent conditions.

The entire project was under the direction of JAY M. SAVAGE, who is now located at Pomona College, Claremont, California, with suggestions from the Curator of Herpetology, E. R. DUNN. Funds for the program were provided by the Academy and by a grant from the American Philosophical Society.

Future upkeep and routine curatorial tasks relating to the herpetological collections will be handled by the Department of Fishes at the Academy. Requests for loans should be addressed to the Fish Department for processing. Loans will still, of course, be subject to the approval of DR. DUNN and the Academy's director, DR. H. RADCLYFFE ROBERTS.

Copeia mailing dates, 1954

ACCORDING to information received from the printer, and judging from post marks, COPEIA during 1954 was put in the mail at Baltimore on the following dates: No. 1 on Feb. 19; No. 2 on May 5 (domestic copies) and May 6 (foreign copies); No. 3 on July 29, and No. 4 on Oct. 28 (delivered to post office by Waverly Press night shift).

News notes

ON October 15, 1954, the South Pacific Fishery Investigations of the U. S. Fish and Wildlife Service moved its headquarters from Stanford University to the Scripps Institution of Oceanography of the University of California, at La Jolla, Calif., where a portion of the

staff has been located for a number of years. JOHN C. MARR, Chief of the South Pacific Fishery Investigations, will also serve as Director of the University's Marine Life Research Program. These two organizations, the California Academy of Sciences, the California Department of Fish and Game and the Hopkins Marine Station of Stanford University, are engaged in a cooperative study of marine resources, with major emphasis on the Pacific sardine and ecologically associated species, such as the northern anchovy, jack mackerel, Pacific mackerel, and hake. Other staff members of the South Pacific Fishery Investigations include E. H. AHLSTROM (Assistant Chief), R. C. COUNTS, F. E. FELIN, R. M. GILMORE, D. KRAMER, R. LIVINGSTONE, J. MACGREGOR, G. MATTSON, R. W. MORRIS, C. P. O'CONNELL, J. R. THRAILKILL, A. M. VROOMAN, and T. M. WIDRIG. The new mailing address for all of these individuals is: South Pacific Fishery Investigations, U. S. Fish and Wildlife Service, Box 271, La Jolla, California.

JOSEPH R. SLEVIN, Curator of the Department of Herpetology, California Academy of Sciences, was given the Academy's highest award when he was named Honorary Member at the annual meeting held on October 6, 1954.

The honorary degree of Doctor of Science was conferred on JAMES RODENBURG SLATER at the 66th annual Commencement Day exercises of the College of Puget Sound, held on May 30, 1954. DR. SLATER, who retired in 1951, was head of the Department of Biology at the College for 32 years.

The Rockefeller Foundation has given the University of California one million dollars for the support of research in marine biology at the University's Scripps Institution of Oceanography, La Jolla, California. The grant will be expended over an eight-year period. It will be used to strengthen present research projects and initiate new ones. A visiting professorship and four resident professorships will be established, in addition to several graduate fellowships and post-doctoral fellowships. Plans also include improvements in laboratory equipment and facilities and greater use of the University's fleet of five ships for experimental work on marine plants and animals in the open sea far from land. The Institution is already committed to a broad program of biological research. It is one of the five agencies working on the California Cooperative Oceanic Fisheries Investigations, a study of the state's pelagic fishes, especially the sardine. Recently another of the cooperating groups, the South Pacific Fishery Investigations of the U. S. Fish and Wildlife Service, moved its headquarters to Scripps. Also associated with the Institution is the main research laboratory of the Inter-American Tropical Tuna Commission. The La Jolla campus is, in addition, the headquarters of the University's Institute of Marine Resources, which is designed to apply basic research throughout the University to the practical problems of increasing man's use of the oceans.

A new marine biological station, the Cape Haze Marine Laboratory, will be opened at Placida, Florida in January, 1955. Situated on Gasparilla Sound, it offers opportunities for studying the fauna and flora of the Gulf of Mexico and will be open to investigators and students in the near future. The laboratory is the first part of a cultural center planned for Cape Haze, a development sponsored by WILLIAM H. VANDERBILT and ALFRED G. VANDERBILT. A museum collection of local fishes and facilities for keeping living specimens have been started. The laboratory will be under the directorship of DR. EUGENIE CLARK.

The Meade Natural History Library of Tulane University is sponsoring a proposal to microcard the F. J. W. SCHMIDT Memorial Library, Chicago Natural History Museum. This library of 12,000 to 15,000 selected reprints (200,000 to 225,000 pages) was accumulated by K. P. SCHMIDT over a period of 40 years. The cost of the microcard file of this library will be $600 to $900; the final price cannot be determined precisely in advance. The microcarding will be done only if sufficient orders are received to meet the cost of manufacture. To place an order for a file, write immediately to: FRED R. CAGLE, Department of Zoology, Tulane University, New Orleans, Louisiana.

DR. L. C. STUART, Institute of Human Biology, University of Michigan, left on January 3 to continue his field investigations on the herpetofauna of Middle America. After a few weeks in southern Mexico he plans to spend several months in Guatemala. DR. STUART will return to the University in September.

HOWARD ELLIOTT WINN has fulfilled the requirements for the Ph.D. degree at the University of Michigan and is now working on the locomotion of fishes in the Department of Fishes and Aquatic Biology at the American Museum of Natural History. The title of his thesis is: "Comparative Reproductive Behavior and Ecology of Fourteen Species of Darters." He spent two months last summer at the Lerner Marine Laboratory, Bimini, and expects to return there for about two months early this year.

WILLIAM RALPH TAYLOR, who for the past several years has been enrolled as a graduate student in the Museum of Zoology, University of Michigan, accepted a position with the Louisiana Department of Wildlife and Fisheries, effective on November 1 last, and is now stationed at West Monroe (Box 308), Louisiana. His dissertation on the systematics of the catfish genus *Noturus*

is now in advanced form and should be completed this spring.

The graduate studies at Michigan of C. LAVETT SMITH, JR., have been interrupted by a call to military service. He is currently stationed at the Tropical Research Medical Laboratory, San Juan, Puerto Rico. (Mail may be addressed to PVT. C. L. SMITH, 9904 TU. APO 851, % Postmaster, New York, New York.)

JOHN T. GREENBANK is accompanying ROBERT R. MILLER on field work in western Mexico, largely on the ecology and behavior of certain freshwater fishes. The work is expected to last from February until the middle of May, but DR. MILLER does not anticipate returning to Ann Arbor until mid-July.

The following publication, a continuation of DR. TANAKA'S work, is now available at $1.50 per copy or $12.00 for 10 copies (postage included): "Figures and Descriptions of the Fishes of Japan," vol. 50, by TOMIYAMA and ABE, including a systematic index of the fishes described in vols. 1–50. It may be ordered from TOKIHARU ABE, Kotakecho 2670, Nerima, Tokyo, Japan.

ASIH 1955 meeting

THE next annual meeting of the American Society of Ichthyologists and Herpetologists is to be at the California Academy of Sciences, in San Francisco, on June 27 to July 2, 1955.

ASIH, BOARD OF GOVERNORS, 1955

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Gender of *Notropis*

ICHTHYOLOGISTS, generally, will be concerned with a question now being considered by the International Commission on Zoological Nomenclature, on whether the generic name *Notropis* shall continue to be considered as of masculine gender (following almost-universal past practice) or whether the classical derivation (feminine) should decide the gender. In the latter case the numerous adjectival trivial names would be corrected. For details on the question, the reader should refer to The Bulletin of Zoological Nomenclature, vol. 9, part 9, pp. 272 to 277. It should be noted that two questions are involved: the general principle of the gender of classical names ending in *-tropis*, and the individual case of the name *Notropis*. Those who wish to express opinions should write to MR. FRANCIS HEMMING, Secretary, International Commission on Zoological Nomenclature, 28 Park Village East, Regent's Park, London N.W.1, England, referring to File Z.N.(S.)663. Communications should reach MR. HEMMING before April 22, 1955.

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